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Final report





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# Preface

The work reported herein was funded by the U.S. Army Engineer District, Alaska (CEPOA), under Funding Document Number WCIJUW01465645, dated 15 June 2000. The technical point of contact at CEPOA for this work is Mr. Wayne M. Crayton (CEPOA-EW-CW).

The principal investigator for this work at the U.S. Army Engineer Research and Development Center (ERDC) was Dr. James Wakeley, Environmental Laboratory (ER-W). Work by ERDC for the Akutan Harbor study involved three separate studies: a wetland delineation, an elevation survey of the study area and development of a digital elevation model, and a geologic/hydrologic assessment. This reported presents the results of the geologic/hydrologic portion of the work performed in support of the Akutan Harbor feasibility study.

Field work for the geologic/hydrologic study was performed during the period 14 to 24 August 2000 by Mr. Joseph B. Dunbar, Engineering Geology and Geophysics Branch (EGGB), Geosciences and Structures Division (G&SD) Geotechnical and Structures Laboratory (GSL), ERDC. The following report was prepared by Mr. Dunbar, Ms. Maureen K. Corcoran, and Mr. William L. Murphy, EGGB. Ms. Corcoran and Mr. Murphy performed the groundwater modeling and estimated the impacts of saltwater intrusion caused by harbor construction.

The work at ERDC was under the direct supervision of Dr. Lillian Wakeley, Chief, EGGB, and under the general supervision of Dr. Reed L. Mosher, Acting Chief, G&SD, and Dr. Michael O'Connor, Director, GSL. Dr. Bryant Mather is Director Emeritus, GSL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

# 1 Introduction

## Purpose and Scope

This work supports the environmental impact and feasibility studies by the Planning Division of the U.S. Army Engineer District, Alaska (CEPOA-EN-CW), for the proposed development of a small-boat harbor at the head of Akutan Bay, Akutan Island, Alaska (Figure 1). The commercial fishing industry, the seafood processing industry, and the city of Akutan support development of a harbor facility at the head of Akutan Bay. This location is well-suited because it is ice-free during the winter months. A harbor facility on Akutan Island would increase the capacity of winter storage for the fishing fleet in the Aleutian Islands and bring additional economic growth to the city of Akutan.

Construction of the proposed harbor involves dredging a 9.1- to 15.2-m- (30- to 50-ft-) deep basin within a wetland area at the head of Akutan Bay. Three project alternatives have been identified, which involve different levels of wetland and terrestrial impacts. At the time of this study, no final decision was made on which alternative would be selected. For purposes of this investigation, the project plan encompassing the maximum land area was selected for detailed study and analyses.

Work by the U.S. Army Engineer Research and Development Center (ERDC), for CEPOA-EN-CW for the Akutan Harbor project involves three separate studies: (1) a wetland delineation, (2) a site survey and development of a digital elevation model, and (3) a geologic/hydrologic assessment. Work for the wetland delineation and the site survey/digital elevation model are presented as separate reports (Wakeley in preparation, Berry and Graves in preparation). This report presents the results of a reconnaissance-level field study to characterize the geology, geomorphology, and hydrology of the proposed harbor area at the head of Akutan Bay.

The primary purpose for the hydrogeologic investigation was to determine the impacts to the groundwater table from harbor construction. A major environmental concern and focus of this study was to estimate the onshore movement of the saltwater wedge in the impacted area due to harbor construction. Primary objectives of this study were to determine the geology of the harbor area to define important aquifer characteristics of the wetland area. Important aquifer characteristics include the elevation and direction of flow of

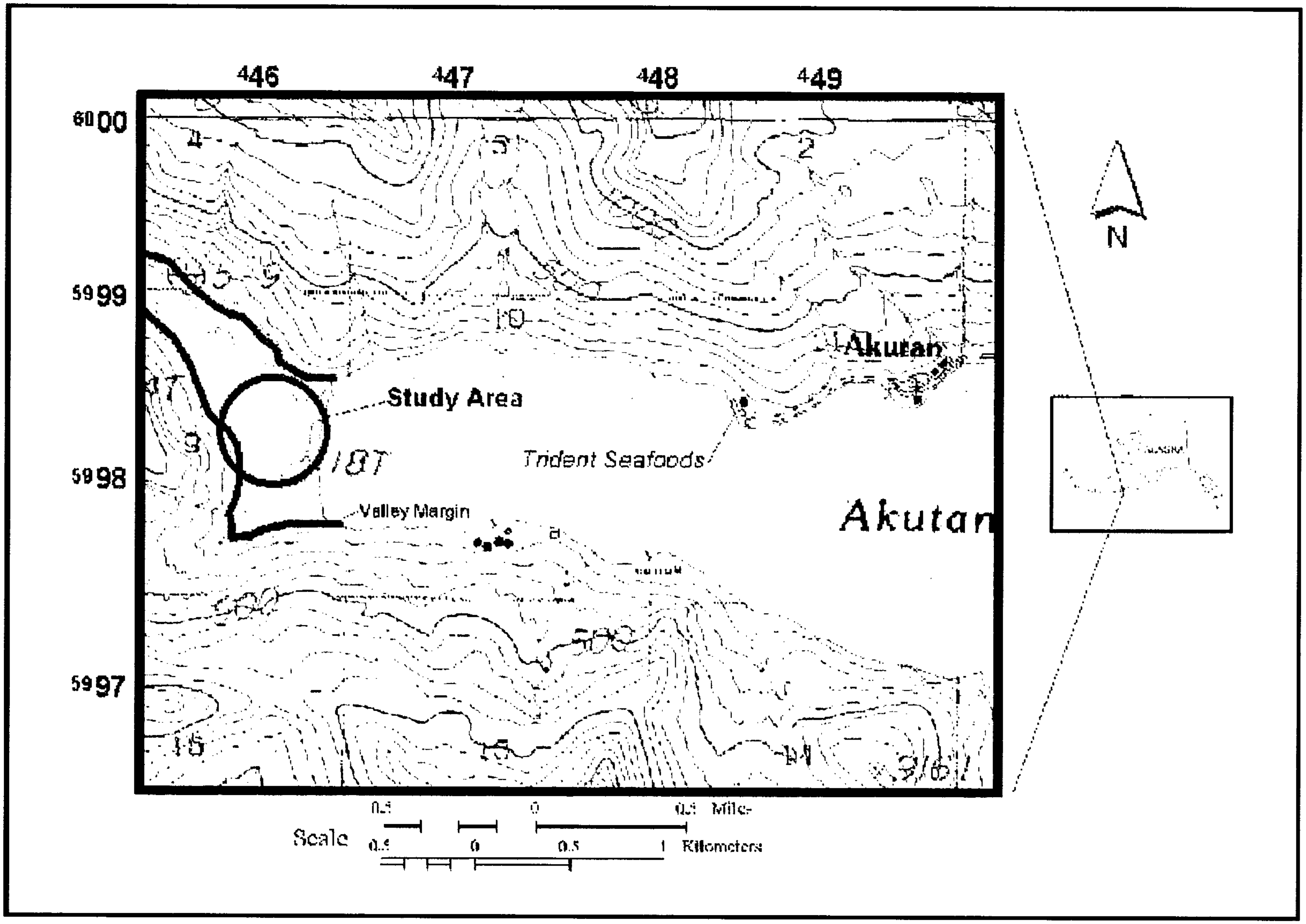



Figure 1. Location map showing study area, city of Akutan, Trident Seafoods, and surrounding topography. Contours are in feet mean sea level (from Unimak A-6, USGS 1:62,500 topographic quadrangle). Map shown with Universal Transverse Mercator (UTM) grid on border

groundwater, character of the sediments and permeability of the shallow aquifer, and depth to the saltwater wedge.

Tasks performed during the course of this investigation include both field and office work. Field work consisted of a site reconnaissance, an elevation survey, hand augering of soil borings at selected locations, installation of monitoring wells, measurement of water levels in wells and stream gages, and a slug test to determine aquifer permeability. Additional tasks included a background literature survey, geologic mapping from aerial photography, laboratory analyses of selected soil samples, hydrogeologic modeling, data reduction and analyses, and preparation of a final report.

The original purpose of this study was to address the maximum impacts caused by the proposed harbor construction. The harbor outline was changed in April 2001. As now proposed, the harbor is significantly smaller than the maximum project plan on which this study is based (Figure 2). The smaller plan will generally have a smaller impact to the project area than the larger harbor design. The April 2001 harbor boundary is not depicted on illustrations in this report because definition of the new outline postdates the hydrogeologic modeling and completion of the study. The original scope of this study was to look at the larger area and the general impacts. This report also does not address the placement of dredge spoil within the project area and potential impacts to surface drainage and groundwater flow because dredge-spoil impacts were not included in the scope of the original study.

## Study Area

Akutan Island is located at 54°07'N latitude and 165°55'W longitude and is part of a volcanic chain of islands or volcanic arc that forms the Aleutian Islands. Mt. Akutan, one of the most active volcanoes in the Aleutian Arc, is approximately 9.6 km (6 miles) west of Akutan Bay. The proposed harbor facility lies in a glacially carved, steep-walled, volcanic bedrock valley, or fiord, at the head of Akutan Bay (Figure 1). Shown on the aerial photograph in Figure 2 is the project outline or plan encompassing the maximum land area and the most recent project outline as of April 2001. The study area of interest for the hydrogeologic investigation corresponds to the limits of the photograph in Figure 2.

Besides the steep valley walls that border the study area, attention is drawn to the three prominent creeks or streams that are present in Figure 2. These creeks are unnamed hydrologic features on the U.S. Geologic Survey (USGS) topographic map of Akutan Island (see enlarged map view in Figure 1). Each creek is marked by a delta that extends into Akutan Bay (Figure 2). The northern-most creek is the largest and is referred to as North Creek in this report. The next largest creek is situated along the southern margin of the study area, and it is referred to as South Creek in this report. The smallest creek occupies the central part of the study area and drains a significant portion of the marsh area. This latter creek is referred to as Central Creek.

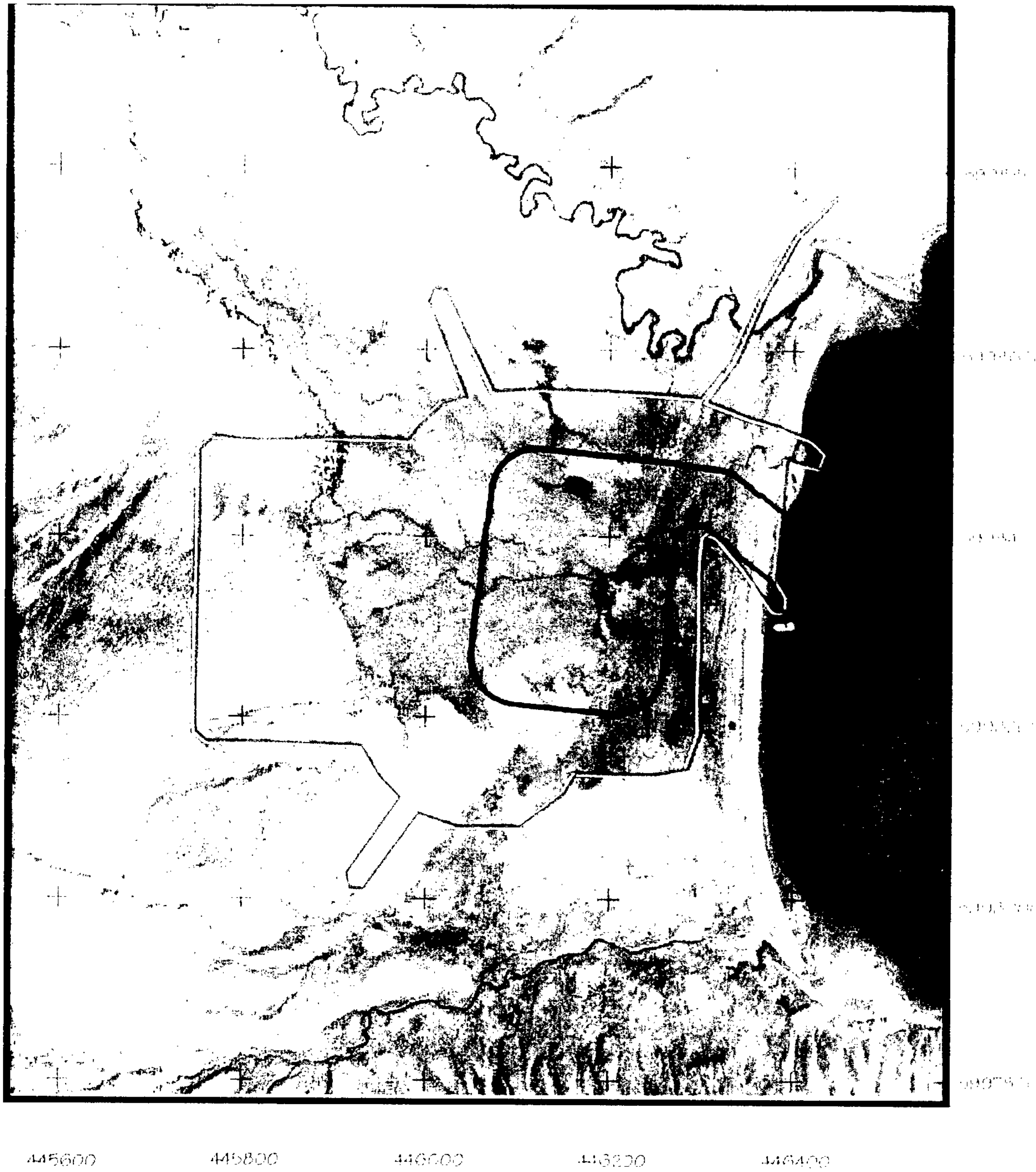


Figure 2. Photograph of study area showing harbor plan with maximum land area (outline in red) and latest plan as of April 2001 (outline in black). Grid datum is UTM (Zone 3, North American Datum (NAD) 1983). Grid interval on photograph is 200 m (61 ft)

# 2 Study Methods

## Approach

A reconnaissance-level hydrogeologic investigation is a general assessment of the study area based on a background literature survey, identification of landforms from aerial photography and a brief site visit. Usually, the site visit involves the verification of geologic and landform boundaries that were identified on the aerial photography, and includes the study of stratigraphy from selected outcrops, stream bank cuts, and shallow hand auger cores of designated landforms. Together, these data are used to characterize the geology and stratigraphy of the study area. Hydrologic characteristics of the site are based on study of the surface drainage, installation of shallow monitoring wells, careful measurement of water elevations in wells and streams, tide gage data, and aquifer slug tests. Collectively, these data form the basis for assessing the site hydrogeology and provide the foundation for subsequent modeling efforts. A reconnaissance level investigation is the minimum effort required for an expert opinion on the site hydrogeology.

## Previous Studies

Construction of a harbor at the head of Akutan Bay is not a new idea. The city of Akutan in 1982 contracted with Peratrovich and Nottingham, Inc., Anchorage, Alaska, to evaluate the feasibility of building a harbor at the head of the bay. Eleven trenches were dug with a backhoe as part of this effort to characterize the underlying soils (Peratrovich and Nottingham 1982). Trench locations and streaming gage stations are identified in Figure 3. Soils in the Peratrovich and Nottingham trenches were logged by a geologist. Trench depths ranged from 2.1 to 7.9 m (7 to 26 ft). Laboratory testing of sediment grain size was performed on a few selected soil samples obtained from the trenches. Furthermore, their study measured stream flow discharge for North and South Creeks during a 10-day period in August 1982. These discharge measurements are the only known such measurements for North and South Creeks.

Another engineering study of importance to the hydrogeologic evaluation is the geotechnical work in support of the current harbor project by Shannon and Wilson (1998, 1999). Two sites were considered for the proposed harbor

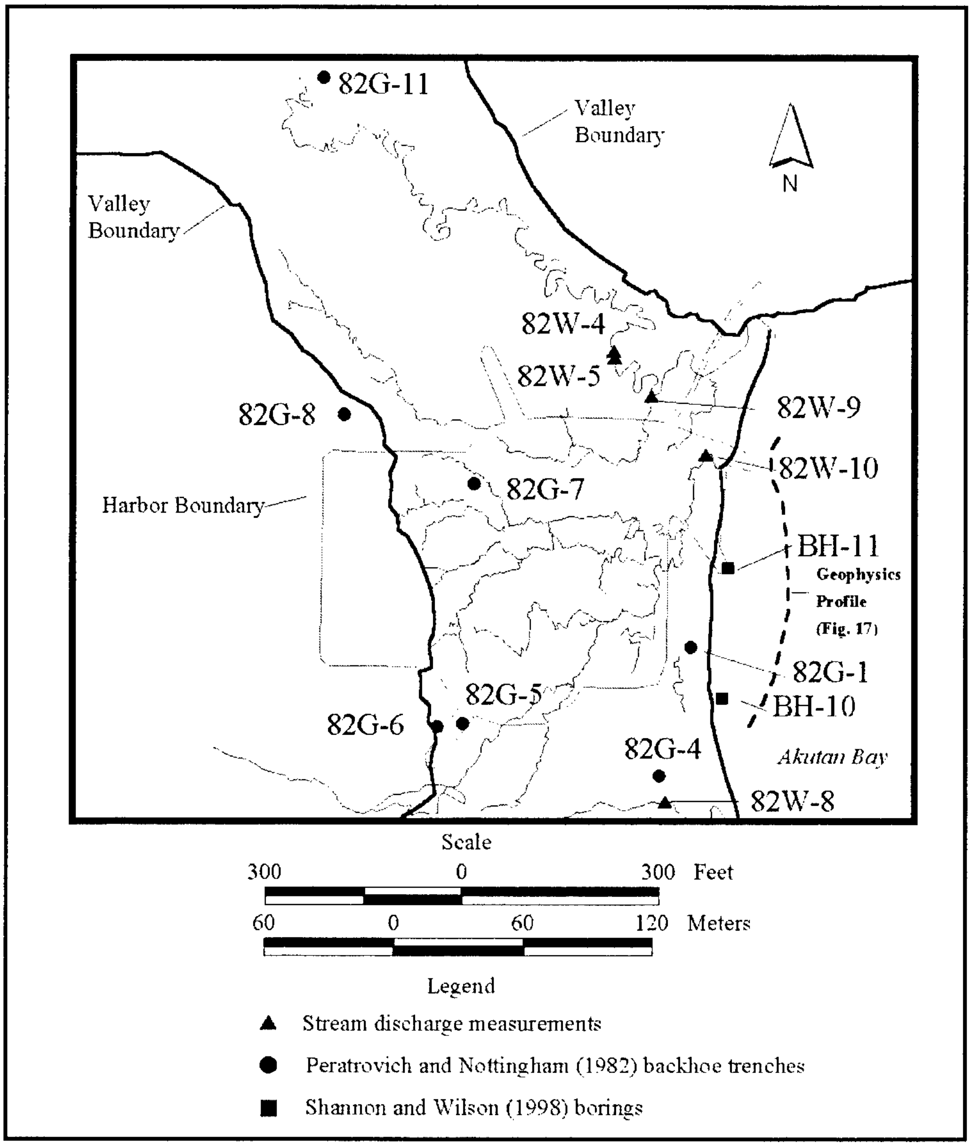



Figure 3. Map showing location of Peratrovich and Nottingham (1982) backhoe trenches and stream gaging stations, and Shannon and Wilson (1998) borings

facility, a location adjacent to Trident Sea Foods (Figure 1) and the current site of interest at the head of Akutan Bay. As part of the characterization of the site at the head of the bay, two deep borings were drilled and a seismic reflection line was shot approximately 60.9 to 106.7 m (200 to 350 ft) offshore from the beach (Figure 3). Shannon and Wilson's study is important because it provides data on the deep sediments, stratigraphy, and geometry of the bedrock valley in Akutan Bay.

Other important published studies that have bearing on the current work at Akutan Island include a streamflow report on siting a hydroelectric facility for the City of Akutan (Carrick and Ireland 1989) and several reports on the volcanic geology of Akutan Island (Waythomas 1999, Richter et al. 1998, Waythomas et al. 1998). The streamflow report by Carrick and Ireland (1989) provides useful background information on climate and precipitation for Akutan Island. Unfortunately, the streams selected for long-term monitoring by Carrick and Ireland study are outside the current area of interest. General background geologic information for Akutan Island is contained in the report describing the geologic map of Akutan Island (Richter et al. 1998). Detailed information on volcanic stratigraphy and associated historic eruptions are described by Waythomas et al. (1998).

In summary, a fair amount of geologic and geotechnical literature about Akutan Island has been published in spite of its remote location. The available literature contains geologic background information and boring, seismic, and streamflow data. Together, these data provide information addressing the general site geology, stratigraphy, and groundwater hydrology.

# Field Studies

## Auger borings

Ten auger borings were drilled in the study area (Figure 4). An 8.255-cm (3-1/4-in.) bucket auger was used to drill the borings (Figure 5). Monitoring wells were installed in each borehole (Figure 6). A drilling log was made describing the sediments encountered in each boring. Logs of borings are presented in Appendix A. Soil texture is based on the Unified Soil Classification System (USCS) (USACE 1995) (Table 1). Boring locations identified on each log are referenced to the UTM projection (Zone 3), North American Datum (NAD) of 1983.

## Monitoring wells

Nine monitoring wells were installed in the study area (Figure 4, designated AKI-1 through AKI-9). Wells in the study area were hand augered to the water table and the well point driven with a sledge hammer below the water table. Driving of well points usually began at the depth where the boring walls would collapse from the pressure caused by water in the saturated zone. Groundwater

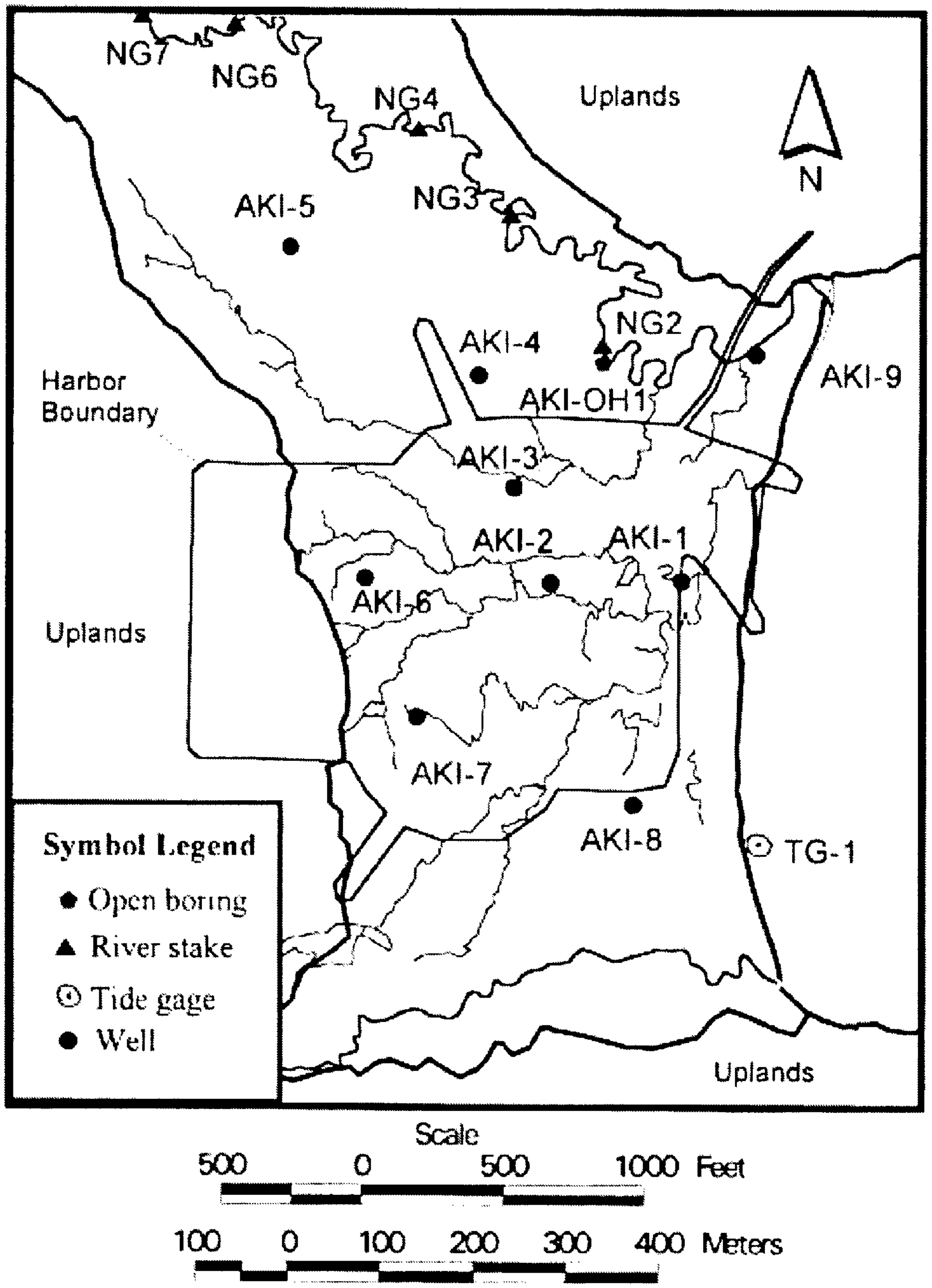



Figure 4. Location of borings, wells, and gages installed during this study

Figure 5. Photograph of a geologist hand augering a soil boring to install a well

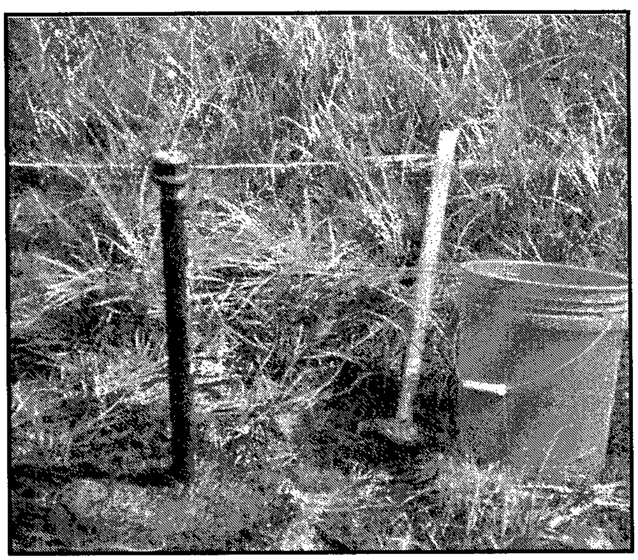


Figure 6. View of installed monitoring well with pipe stickup of about 0.6 m (2 ft)

was generally encountered between 0.6 and 1.2 m (2 and 4 ft) below ground surface as identified on the boring logs in Appendix A.

Well screens were purchased from a drilling supply company. Well screens consisted of a 3.175-cm- (1-1/4-in.-) diam, 91.44-cm- (36-in.-) long perforated, galvanized pipe wrapped with a 0.1178-mm stainless steel mesh (No. 80 – 0.007 in.). Well construction involved connecting the well screens to 1.5-m (5-ft) lengths of heavy duty, 3.175-cm- (1-1/4-in.-) diam pipe with stainless steel couplings. All pipe joints were wrapped with teflon tape to ensure a water-proof seal. Special drive caps were used to hammer the well screen to the desired depth. Generally, each well was driven about 0.9 to 1.5 m (3 to 5 ft) below the water table. Approximately 0.6 m (2 ft) of pipe stickup is present at each well location (Figure 6). Filter sand was placed around each well screen to approximately 0.9 m (3 ft) above the screen, followed by bentonite to the surface. Filter sand consisted of beach and river sand obtained locally. Monitoring wells were purged with a bailer following installation to develop the wells.

Detailed information about each well is presented on the respective boring logs in Appendix A. Well data in Appendix A include screen interval and elevation, depth and thickness of filter sand, bentonite, and depth at which groundwater was first encountered. Water level measurements were made daily with a Solinst electronic sensor following the well installation. Water level measurements are presented in Appendix B.

### Tide gage

A tide gage (pressure transducer) was installed in Akutan Bay below the tide base at the start of the field investigation. The gage location is shown in Figure 4. The tide gage sensor was programmed to record the water level in the bay at 15-min intervals. Tide gage measurements are presented in Appendix C.

### Stream gage

Survey gages were installed in the stream bed of North Creek at locations shown in Figure 4. Stream gages are designated NG-4 through NG-7. The gage consisted of a surveyed staff gage. Water levels in North Creek were recorded each day as part of the well measurement process. Stream gage elevations are presented with the groundwater data at the end of Appendix B.

### Well AKI-1

A pressure gage was installed in monitoring well AKI-1 to observe if the water table near the shoreline was influenced by tidal changes in the bay and also to conduct a slug test to determine in situ aquifer permeability. The sensor was programmed to record water levels in the monitoring well at 30-min intervals. Individual water level measurements are presented in Appendix D.

A slug test was performed near the end of the field work to measure aquifer permeability at well AKI-1. The sensor was reprogrammed for the slug test to record water level measurements every 0.5 sec. Results of the slug test data are presented in Appendix E.

### Site survey

All wells, gages, and other miscellaneous points of interest were located by a two-man survey crew with a global positioning system (GPS). Vertical and horizontal accuracy of surveyed locations is approximately 1 to 2 cm. Detailed information about the survey, equipment, and data reduction is presented in Berry and Graves (in preparation). The report by Berry and Graves includes a site topographic map.

## Laboratory Testing

### Texture

Six soil samples were submitted for Geotechnical and Structures Laboratory (GSL) testing. Results of the textural classification are presented in Table 1 and Figure 7. Classification of soil texture is according to the USCS (USACE 1995).

**Table 1**
**Soil Texture for Akutan Harbor Samples**

| Well/Sample | Depth, ft (m) | USCS |
|---|---|---|
| AKI-1 | 3 - 5 (0.91 - 1.524) | SP (sand and gravel) |
| AKI-4 | 4.5 - 5 (1.372 - 1.524) | SP |
| AKI-5 | 3 - 5 (0.91 - 1.524) | SP |
| AKI-7 | 3.5 - 5 (1.067 - 1.524) | SP |
| AKI-8-1 | 1.2 - 1.5 (0.366 - 0.457) | SP |
| AKI-8-3 | 4.5 - 5 ((1.372 - 1.524) | SP |

### Permeability

Laboratory permeability tests were performed on three samples: two outer (finer/coarser) and the median grain-size samples (Figure 7). Permeability tests were performed using the constant-head method for granular soils (Headquarters, Department of the Army (HQDOA) 1986). Results of the permeability testing are presented in Table 2.

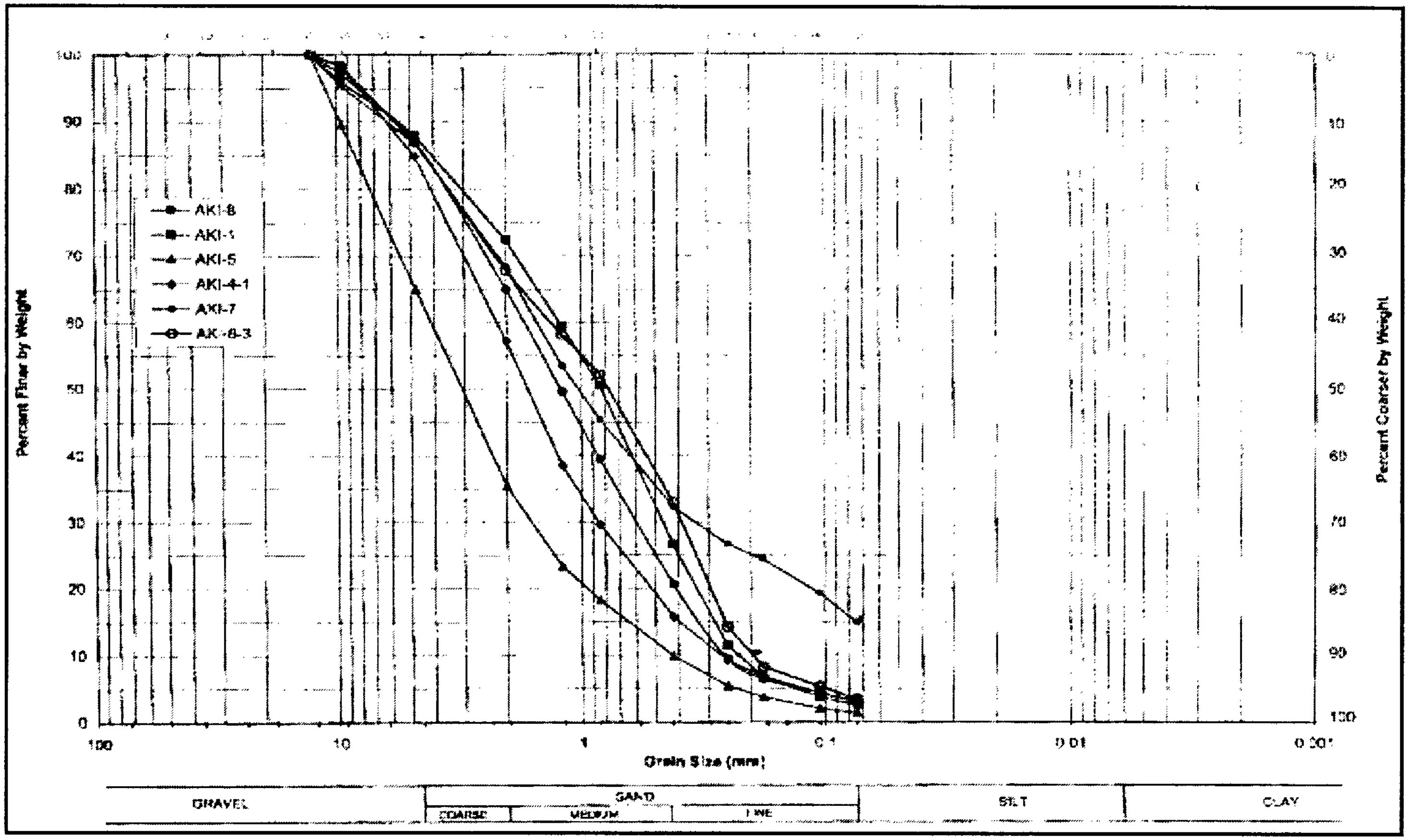



Figure 7. Grain-size curves for Akutan Harbor soil samples, (See Tables 1 and 2 for sample depths and other engineering properties and Appendix A for boring logs)

**Table 2**
**Engineering Properties of Selected Akutan Harbor Soil Samples**

| Sample ID | Permeability $cm^2/sec$ | Wet Unit Weight pcf | Dry Unit Weight, pcf | Moisture Content, % | Porosity | Void Ratio |
|---|---|---|---|---|---|---|
| AKI-5 | 1.3E-02 | 103.7 | 88.1 | 17.7 | 0.47 | 0.88 |
| AKI-7 | 4.8E-03 | 106.5 | 88.8 | 19.9 | 0.46 | 0.86 |
| AKI-8-3 | 1.8E-02 | 110.4 | 84.5 | 30.7 | 0.49 | 0.96 |

# 3 Geology and Geomorphology

## Geologic Setting

A brief summary of the geology of Akutan Island is presented to highlight important physical characteristics of the study area and to understand the origin and processes affecting the island. The collision of the Pacific and North American Plates during the past 5 million years has produced the Aleutian Arc, a series of active volcanic islands that stretch across the northern edge of the Pacific Ocean. Akutan Island is situated approximately midway along the arc. The island measures approximately 28.9 km (18 miles) long by 20.9 km (13 miles) wide.

Akutan Island is composed of a series of Pleistocene (2 million years to 10,000 years ago) and Holocene (10,000 years ago to present) pyroclastic and volcanic flow deposits of dacite to basalt composition from volcanic centers of two different ages. Lavas from the older volcanic deposits form the base of the eastern part of the island and are dated at approximately 1.5 to 3.3 million years old (Richter et al. 1998). The younger volcanic deposits are associated with Mt. Akutan, the volcanic cone situated at the west-central part of the island. Akutan volcano has been one of the most active volcanos in the Aleutian Arc during the Holocene. During historic time alone, at least 27 separate volcanic eruptions have occurred (Waythomas et al. 1998, Waythomas 1999).

In addition to the active volcanism, Akutan Island experienced intense glaciation during the Pleistocene. Glacial erosion deeply scoured the older volcanic rocks on Akutan Island and carved numerous U-shaped valleys up to 500 m deep that extend to the coast in a radial pattern from the center of the island (Wood and Kienle 1990). Following the melting and retreat of continental glaciers in North America between 8,000 and 10,000 years ago, sea level has risen approximately 350 to 400 ft (106 to122 m) and flooded these former ice-filled valleys. The study area and Akutan Bay are situated in a glacially carved valley or fiord that has subsequently been flooded by the recent sea level rise. The steep, U-shaped valley topography characteristic of Alpine glaciation is visible in Figure 1.

Other important geologic mechanisms at work in shaping the physical character of the study area besides active volcanism include Pleistocene glaciation and Holocene sea level rise. Both cause upward vertical movements of the crust. Changes in surface elevation are the result of glacial rebound and tectonic and Holocene sea level rise. Both cause upward vertical movements of the crust. Changes in surface elevation are the result of glacial rebound and tectonic adjustments related to subduction of the Pacific Plate beneath the North American Plate. Glacial rebound is directly related to the removal of the large mass of glacial ice and subsequent buoyancy adjustments (isostasy) of the underlying crust and upper mantle. The subduction of one crustal plate over the other in the Aleutian Arc has produced the rugged chain of volcanic islands. These islands are an active tectonic feature on the earth's surface. They are undergoing tectonic uplift and producing changes in surface elevation at Akutan Island. It has been estimated that the rate of subduction of the Pacific Plate beneath the North American Plate in the Western Peninsula occurs at a rate of approximately 7 cm/year (Jordan and Maschner 2000).

Tectonic and isostatic movements have influenced the relative position of sea level in the study area. Work by Jordan and Maschner (2000) identify several prominent elevated shorelines throughout the eastern third of the Aleutian Arc (i.e., Western Alaska Peninsula). One of these shorelines occurs at 6 to 10 ft (2 to 3 m) above the present sea level and is estimated to be about 1,000 years old based on geomorphic and archeologic evidence. These authors consider many of these shorelines to represent uplift features rather than storm surge phenomena. If their interpretation of origin and age estimates are correct, then the 2- to 3-m shoreline in the east-central Aleutian Arc has been uplifted at a rate of about 2 to 3 mm/year. A similar 2- to 3-m-high relict shoreline or beach deposit is present at the head of Akutan Bay. The presence of this elevated shoreline at the head of Akutan Bay would indicate that a large component of tectonic-isostatic uplift is present in the study area.

## Geomorphic Mapping and Classification

As part of the evaluation of the study area geology, a generalized geomorphic classification of landforms was performed from aerial photography. Photographs of the study area were obtained from AeroMap U.S., Anchorage, Alaska. The most recent aerial photography of the study area was flown in 1983 for the Peratrovich and Nottingham (1982) harbor evaluation (Figure 2). ERDC conducted mapping on a georeferenced, digital version of the 1983 photograph using ArcView, a geographic information system (GIS) software by Environmental System Research Institute (ESRI). The photograph was initially georeferenced to the digital version (i.e., Digital Raster Graphic or DRG) of the Unimak (A-6), 1989 provisional edition, USGS topographic map and later to control points from the site survey. As previously indicated, a UTM projection (Zone 3), NAD 1983 was used for mapping, GPS surveying, and all other field work requiring precise locations (Berry and Graves in preparation).

Landforms mapped from the aerial photography are presented in Figure 8. Nine different landform types were delineated. The landform classification is general and does not include numerous, secondary, undifferentiated depositional features. These secondary environments were not specifically identified during the mapping because of the reconnaissance nature of the study and the

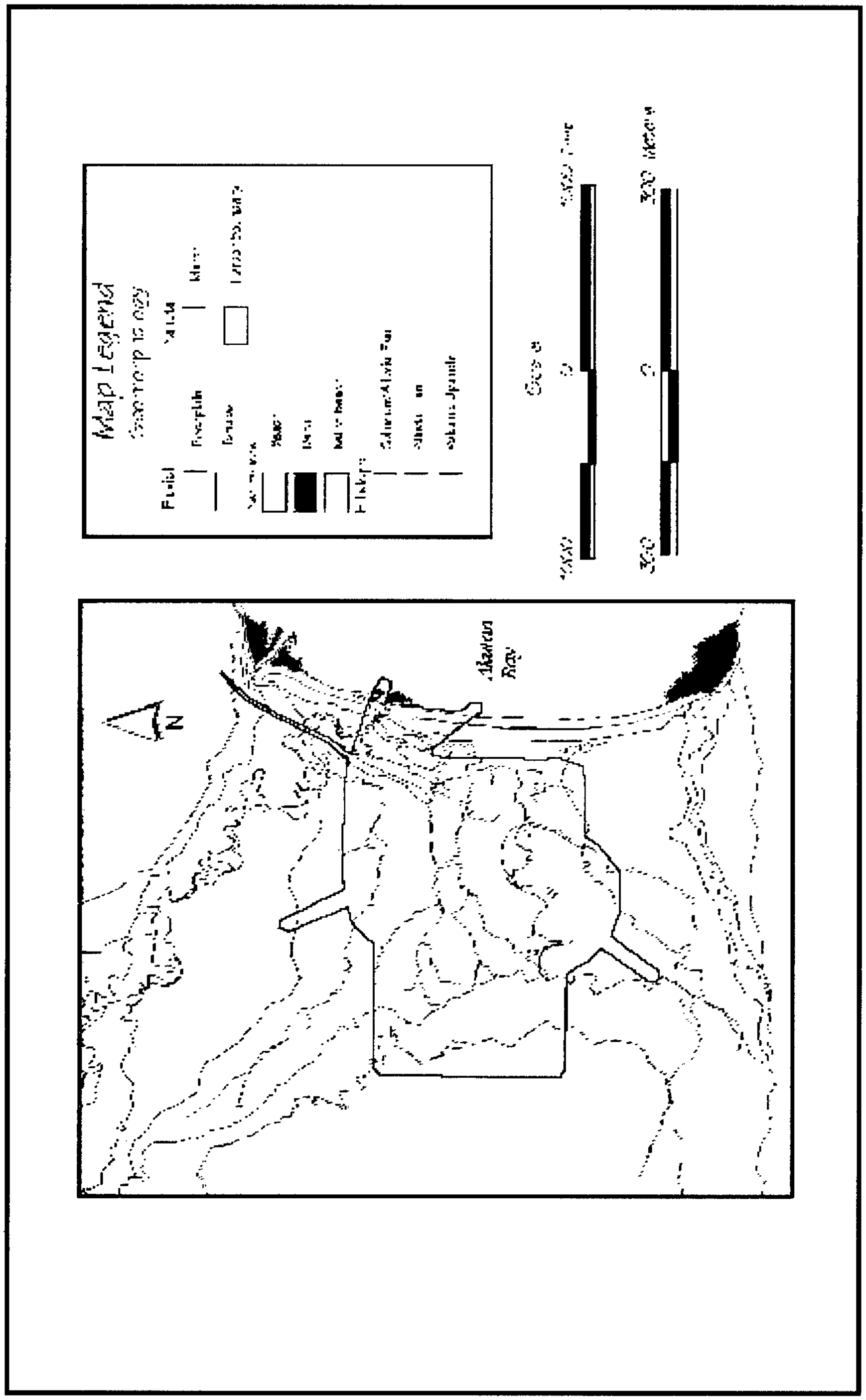



Figure 8. Primary landforms in the study area mapped from aerial photography

(beach, relict beach, delta), paludal (marsh), and hillslope (alluvial fan, colluvium/alluvial fan, and volcanic uplands). A brief description of each major environment is presented below. Detailed descriptions of these landforms, including subordinate environments and associated processes, are contained in numerous introductory geology texts.

## Fluvial Landforms

### Floodplain

The floodplain is the land area adjacent to the active stream or river channel that is subjected to annual flooding. Contained on the active floodplain are several undifferentiated depositional environments. These unmapped environments include abandoned channels or oxbows, abandoned stream courses, point bars, and natural levees. These environments are produced as the stream or river migrates laterally across its alluvial valley. All of these environments are present on North Creek (Figure 2). As previously indicated, these environments were not individually mapped because of the reconnaissance nature of the study and the primary focus on groundwater as opposed to geomorphology. Sediment types observed in channel banks and streambeds are generally coarse-grained. Coarse gravels and cobbles are common in the streambeds (Figure 9), while the streambanks (Figure 10) are formed of finer-grained sediments (silty sands, SM, gravelly sands, SP and SW).

### Terrace

A prominent high-level terrace is present on the south side of North Creek (Figure 8). This terrace separates the central marsh area from the floodplain of North Creek (Figure 11). A terrace represents an abandoned floodplain surface that is situated at a higher elevation than the current floodplain. A terrace is generally not subjected to annual stream flooding, except for occasional flooding events (i.e., 5-, 10-, 15-year floods). Implied in the definition of a terrace is the morphology of the surface, as opposed to the sediments that form this surface. A terrace contains a level or gently inclined surface, bounded along one edge by a more steeply descending slope (Bates and Jackson 1987).

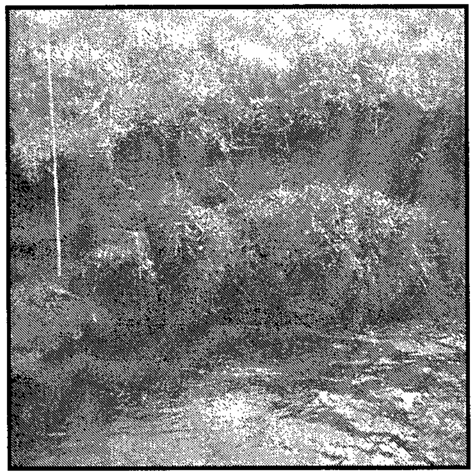
Formation of terraces can occur by several mechanisms. The method most applicable to the area of interest involves vertical downcutting of the stream channel to a lower elevation. Stream downcutting is usually due to changes in climate (precipitation), which influence stream discharge, or base level (regional uplift or a drop in sea level).

During the course of the field work on Akutan Island, it was observed that within the floodplain limits of North Creek, there are two and possibly three unmapped lower terraces. These terraces are present on the southern boundary of the floodplain of North Creek (Figure 12), and as isolated remnants within the floodplain. Their presence is evidence of the magnitude of stream

Figure 9. Typical gravel point bar in North Creek

downcutting that has occurred during the late Holocene. Multiple stream terraces adjacent to North Creek, plus the abandoned beach ridge at the head of the bay, are evidence for an active component of isostatic-tectonic uplift in the study area. The stepped nature and entrenched condition of North Creek near its mouth would suggest that this creek became locked into its present position during the late Holocene instead of migrating freely across the entire valley.

Sediments underlying the terrace are coarse-grained and similar to those present in the bed and banks of North Creek. Two backhoe trenches, 82G-10 and 82G-11, were excavated to depths of 3.35 and 2.44 m (11 and 8 ft), respectively, below ground surface for the Peratrovich and Nottingham (1982) harbor evaluation. Sediment samples from Trench 82G-11 were sieved in the laboratory. Published grain-size curves are available for these samples. Both trenches identify a similar coarse-grained lithology, sand and gravel (SP), to about 1.5 m (5 ft) below ground surface, followed by gravel and sand (SW) to the maximum depth excavated.



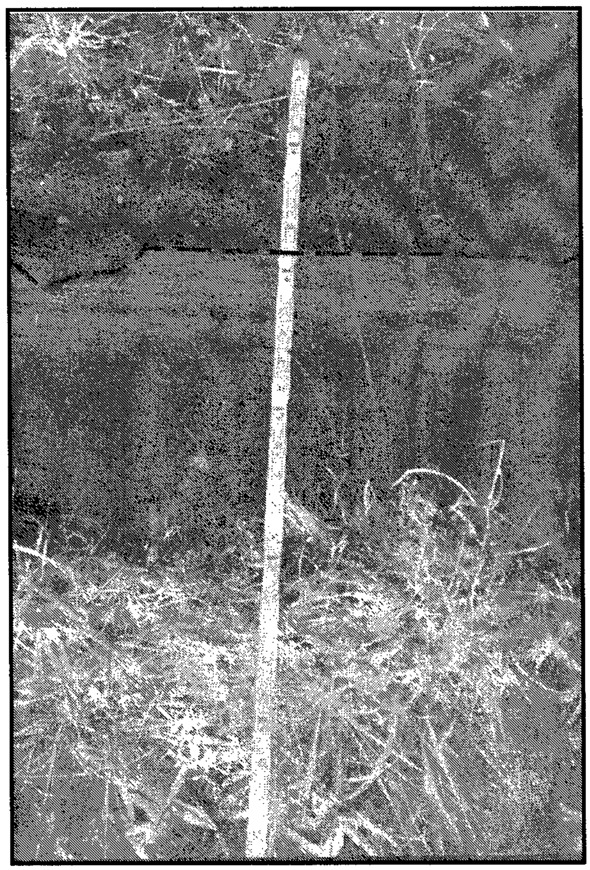


Figure 10. View of bank failure along North Creek (upper photo). Close-up (bottom photo) shows sand and fine gravel organic horizon (above red line in bottom photo), underlain by laminated and thinly bedded silty sand (SM) and gravelly sand (SP). At the base of the bank (not shown), the texture is coarser, composed of gravelly sand (SW) and sandy gravel (GP)

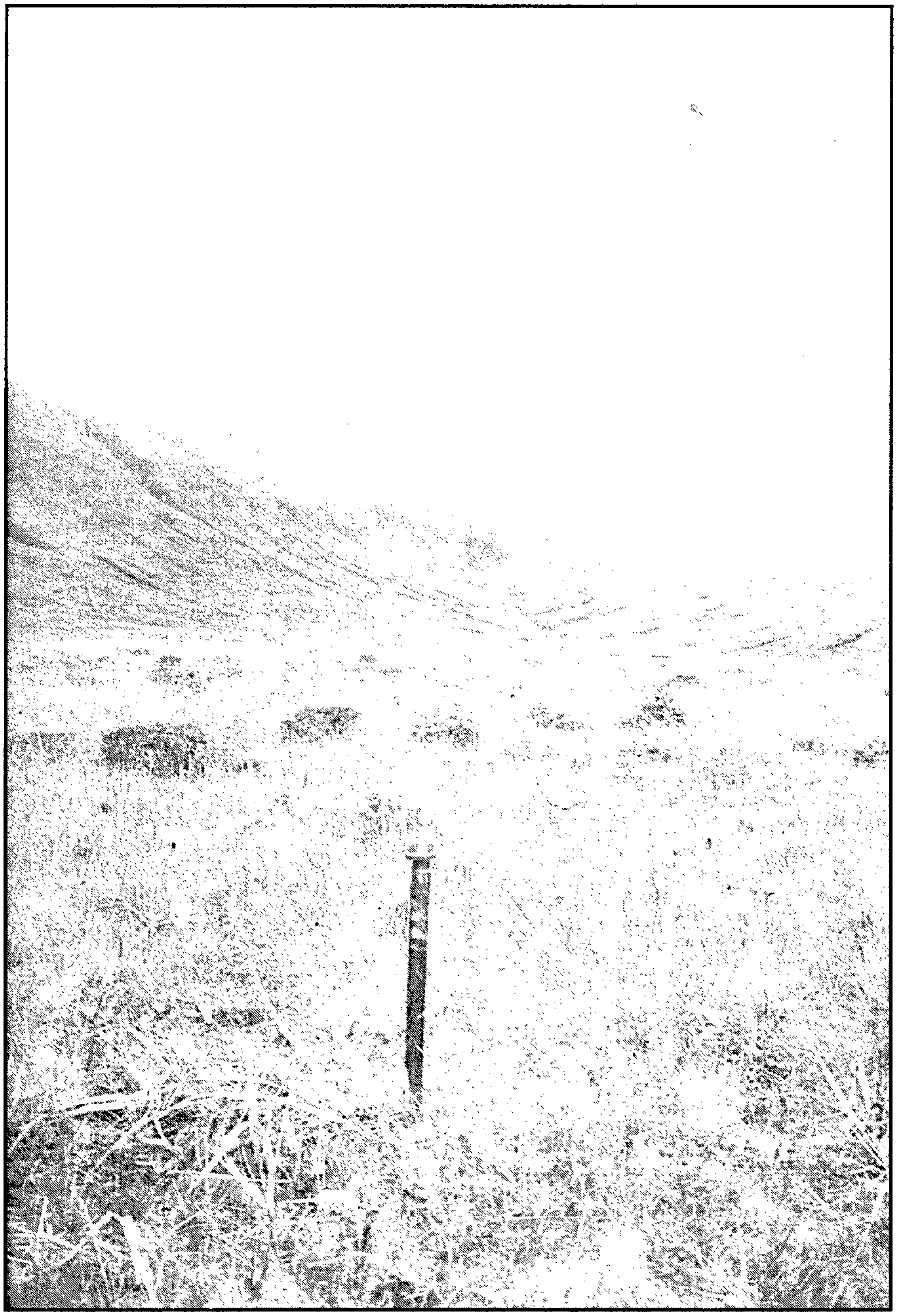


Figure 11. View looking due west of upper terrace at Well AKI-5

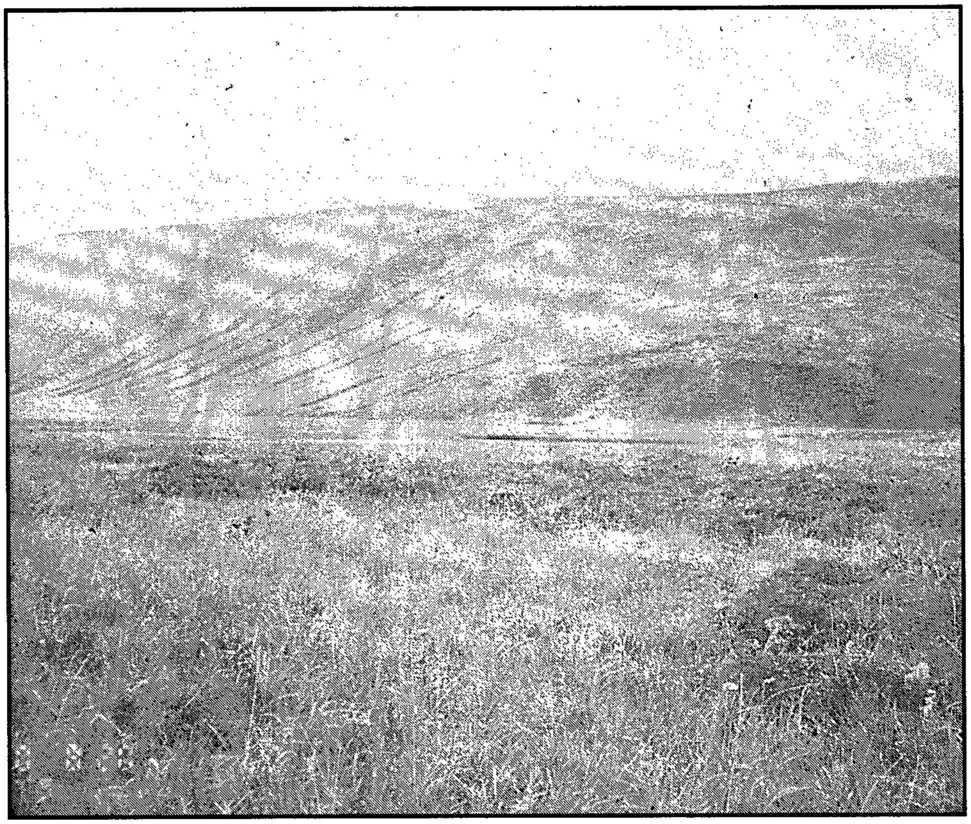


Figure 12. View of unmapped intermediate-level terrace. View is to the southwest from floodplain of North Creek. Scarp in the middle part of photo is about 61 to 91.4 cm (2 to 3 ft). Upper surface corresponds to highest mapped terrace in Figure 8. Intermediate level terrace surface represents an undifferentiated abandoned channel

## Nearshore Landforms

### Delta

Deltas have formed at the mouths of each of the three major creeks (Figures 2 and 8). A delta is a nearly flat area of land that forms by deposition of suspended sediment at a stream's mouth. Deposition occurs at this location because of a decrease in the stream's velocity as it leaves the confined channel and enters the bay. This reduction in stream velocity reduces the capacity of the water to transport sediment in suspension. Sediments deposited at the stream's mouth are reworked by tidal fluctuations, wave wash, storm surge, and other nearshore processes. A photograph of the delta at the mouth of North Creek is shown in Figure 13.

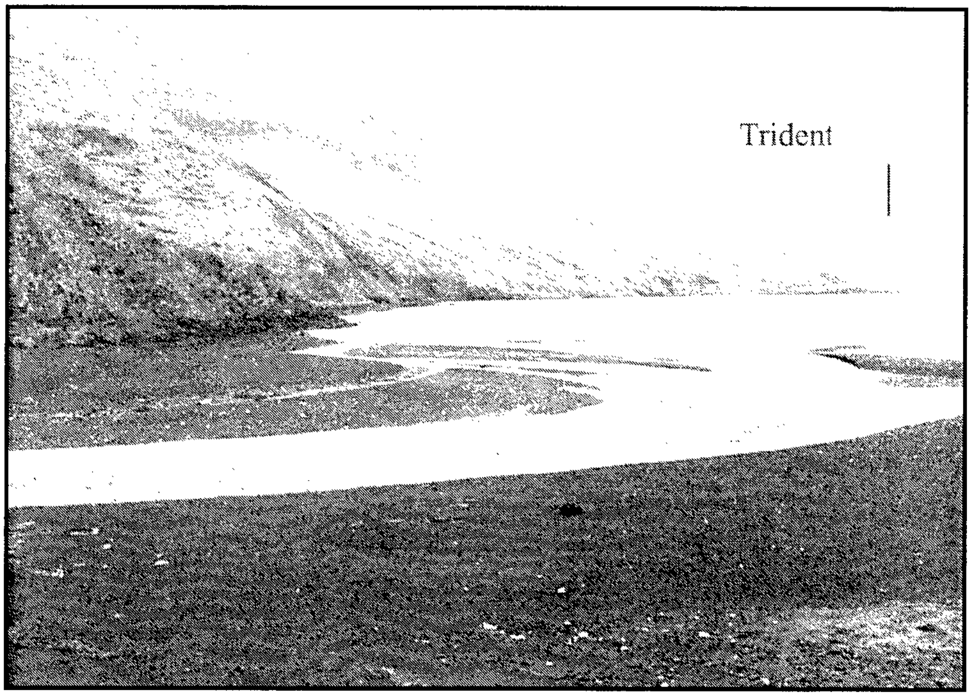



Figure 13. View looking to the northeast at delta at the mouth of North Creek during low tide. Trident Seafoods is in the background of the photo as identified (photo courtesy of U.S. Army Engineer District, Alaska)

## Beach

The active beach represents the interface between the land and the sea. This gently sloping interface is concave in profile and extends landward from the low-water line to the line of permanent vegetation at the highest limit of storm waves. At the head of Akutan Bay, the active beach ranges from 6 to 15.2 m (20 to 50 ft) wide and is composed of unconsolidated volcanic sand and gravel (Figure 14).

## Relict beach

Two abandoned beaches are identified behind the active beach as shown by Figure 8. The relict beach nearest Akutan Bay is one of the most prominent topographic features within the study area (Figure 14). This beach is approximately 2.4 to 3.0 m (8 to 10 ft) high. Evidence for this feature being an abandoned beach, and not the product of modern storm surge or wave runup, includes: (a) the similarity in elevation to other reported abandoned beach ridges (Jordan and Maschner 2000), (b) the magnitude of stream downcutting that has occurred along the lower reaches of North Creek, and (c) the parallel nature of beach ridge construction visible on photography and observed in the field.

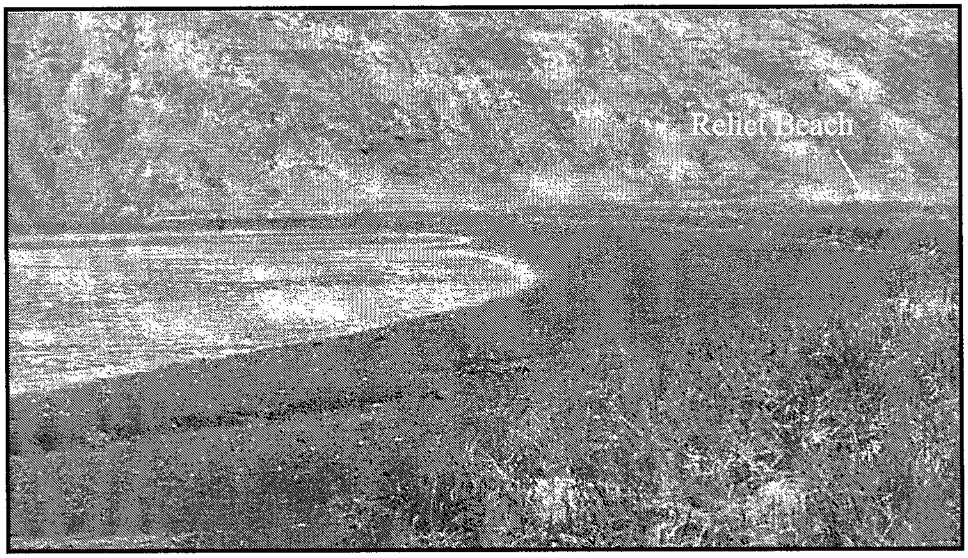



Figure 14. View looking south at sand dominated beach at the head of Akutan Bay. Relict beach is behind the active beach as identified on photograph (courtesy of U.S. Army Engineer District, Alaska)

Sediments forming the abandoned beach are dominated by medium to coarse sand. A backhoe trench was excavated in the beach as part of the Peratrovich and Nottingham (1982) study. Trench 82G-1 was excavated to a depth of 4.6 m (15 ft) below ground surface. Sediments forming the abandoned beach were described as being medium to coarse sand with fine gravel up to 1.3 cm (0.5 in.) in diameter. Approximately 30.5 m (100 ft) south of trench 82G-1, Shannon and Wilson (1998) drilled a boring about 4.6 m (15 ft) offshore. From this boring, two samples were sieved in the laboratory to accurately characterize the sediment texture. The log for this boring identifies gravelly sand (SP) to a depth of nearly 13.4 m (44 ft) below bay level.

## Paludal

Marsh environments and marsh-deposited sediment are termed "paludal." Much of the study area is covered by marsh (Figure 8). Most of the borings augered during the course of this study are located in the better-drained marsh areas. Specific details regarding marsh vegetation and surficial soils as they pertain to wetlands are presented in a separate report by Wakeley (in preparation). Of particular interest to this investigation are the geomorphic and hydrologic aspects of the area mapped as marsh in Figure 8.

Marsh deposits are relatively thin, as demonstrated by auger borings and the Peratrovich and Nottingham (1982) trench excavations. However, 1.8 m (6 ft) of organics were encountered in boring AKI-6, located near the base of the uplands and western edge of the proposed harbor plan (Figure 4). It is highly probable that this area was at one time a former stream course, prior to the present North Creek Valley and the formation of the abandoned beach ridge, or alternatively, an estuary, to account for this greater thickness relative to the surrounding area.

Typically, marsh thickness recorded in the nearby auger borings and trench excavations ranged from 30 to 91 cm (1 to 3 ft).

Marsh deposits of Aktun Harbor are considered geologically young based on their thickness and geologic setting. Marsh sediments are underlain by coarse sandy sediments that point to a fluvial and/or estuarine type setting and filling mechanism for head of Akutan Bay. Development of the marsh area probably coincides with the formation of the now abandoned shoreline or relict beach, and entrenchment of North Creek along the northern valley margin. Local tectonic-isostatic uplift has formed the relict beach and effectively blocked the surface drainage, thereby producing marsh conditions throughout a large part of the central study area.

## Hill Slope

### Colluvium and alluvial fan

Colluvium and alluvial fans are a common feature due to the steep, volcanic uplands that border the study area (Figure 2). Colluvium is the unconsolidated material that is deposited at the base of hillslopes by surface runoff from rain-wash, sheetwash, or creep. Coarse material at the base of hillslopes is commonly referred to as talus. Talus is common in arid settings where physical weathering dominates. An alluvial fan is the mass of unconsolidated sediment that forms where a change in slope occurs on the major streams or gullies that drain the uplands (Figure 15). Landforms created by the various upland surface drainage processes are collectively mapped as colluvium/alluvial fan in Figure 8.

A large alluvial fan was mapped as a separate geomorphic feature because of its topographic prominence in the southern third of the study area (Figure 16). This large fan probably represents the ancestral drainage network from the South Creek basin during the Middle to Late Holocene, prior to formation of the beach ridge and the subsequent stream downcutting that has occurred along South Creek.

### Uplands

Uplands were not specifically studied as part of this investigation. Data from the published literature identify the uplands as consisting mainly of extrusive volcanic tuffs (welded and nonwelded), tephra, and minor intrusive rocks in the form of dikes (Richter et al. 1998, Peratrovich and Nottingham 1982). The uplands are responsible for shaping the hillslope geomorphic features and for channeling surface drainage into the Akutan Bay Valley.

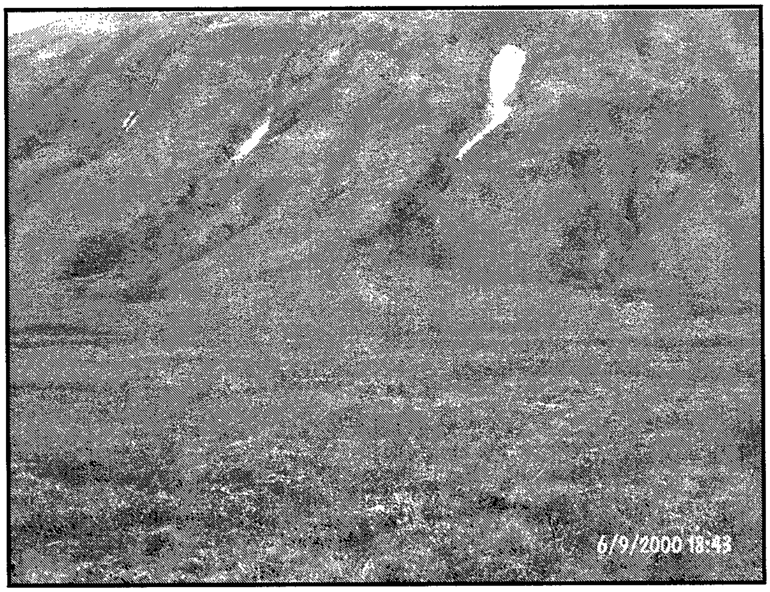



Figure 15. View of alluvial fan at the base of a gully draining uplands (courtesy of U.S. Army Engineer District, Alaska)

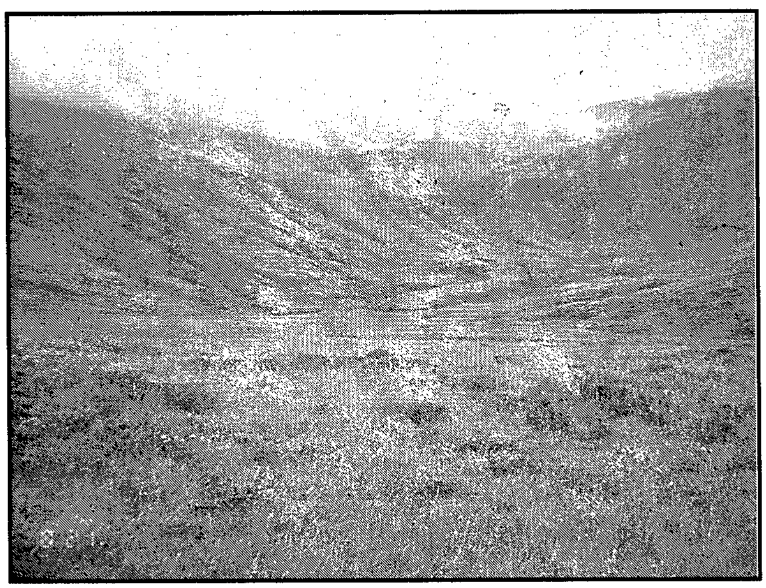


Figure 16. View looking southwest at the large alluvial fan in southern part of the study area. Upland portion of South Creek watershed in background

## Subsurface Geology and Stratigraphy

The study area is situated in a glacially carved valley that has been filled in part by glacial outwash, coarse alluvium, volcanic ejecta, and pyroclastic debris flows during the Holocene. These processes have occurred in concert with eustatic sea level rise. Depth to the underlying volcanic bedrock at the head of Akutan Bay is unknown. Available boring and seismic data do not extend to the bedrock beneath Akutan Bay.

Available data indicate the bedrock valley slopes steeply from where it outcrops along the western limit of the proposed plan to the present shoreline. Geophysical data from the Shannon and Wilson (1998) geotechnical characterization of the upper bay area identify the thickness of the alluvial fill near the shoreline as being in excess of 59.7 m (196 ft) as shown by Figure 17 (see Figure 3 for section location).

Estimates concerning the maximum depth to bedrock beneath the study area are speculative. However, for purposes of evaluating the groundwater and saltwater wedge beneath the study area, it is necessary to focus attention on the shape and depth of the bedrock valley. These parameters will govern the volume of sediments filling this valley, which may influence the configuration of the saltwater wedge beneath the study area. Because of its glacial origin, the valley is U-shaped (Figure 1).

The maximum bedrock depth is interpreted to occur at the shoreline, about midway in the valley. Based on a 45-deg average slope for the valley walls, the estimated depth to bedrock at the shoreline would be approximately 152.4 m (500 ft) below sea level. This estimate may be high if valley scouring is only comparable to the magnitude of sea level drop caused by glacial ice volume changes, which are estimated to range from 106.7 to 121.9 m (350 to 400 ft). For purposes of groundwater impacts evaluated as part of this study, the bedrock valley is estimated to be 106.7 to 152.4 m (350 to 500 ft) deep at the shoreline. It must be stressed again that no data are available to determine the exact bedrock depth.

In addition to the valley geometry, the type of sediments filling the valley, as well as the bedrock permeability and degree of fracturing, will influence the movement of groundwater beneath the study area. The unconsolidated valley fill beneath the study area represents the accumulation of Pleistocene and Holocene sediments derived from a variety of sources: volcanic eruptions, glacial ice, glacial melt water, precipitation-driven upland drainage, valley streams, and near-shore processes. At any specific time during the Holocene history of the study area, various depositional environments similar to those active today were in place, except at lower eustatic sea levels than the present. The record of these activities is reflected in the sedimentary deposits contained in the Akutan Bay Valley.

Offshore boring data from the geotechnical characterization of the proposed harbor indicate a relatively uniform gravelly sand (SP) to about 12.2 m (-40 ft) msl (Shannon and Wilson 1998). Seismic data indicate this gravelly sand unit

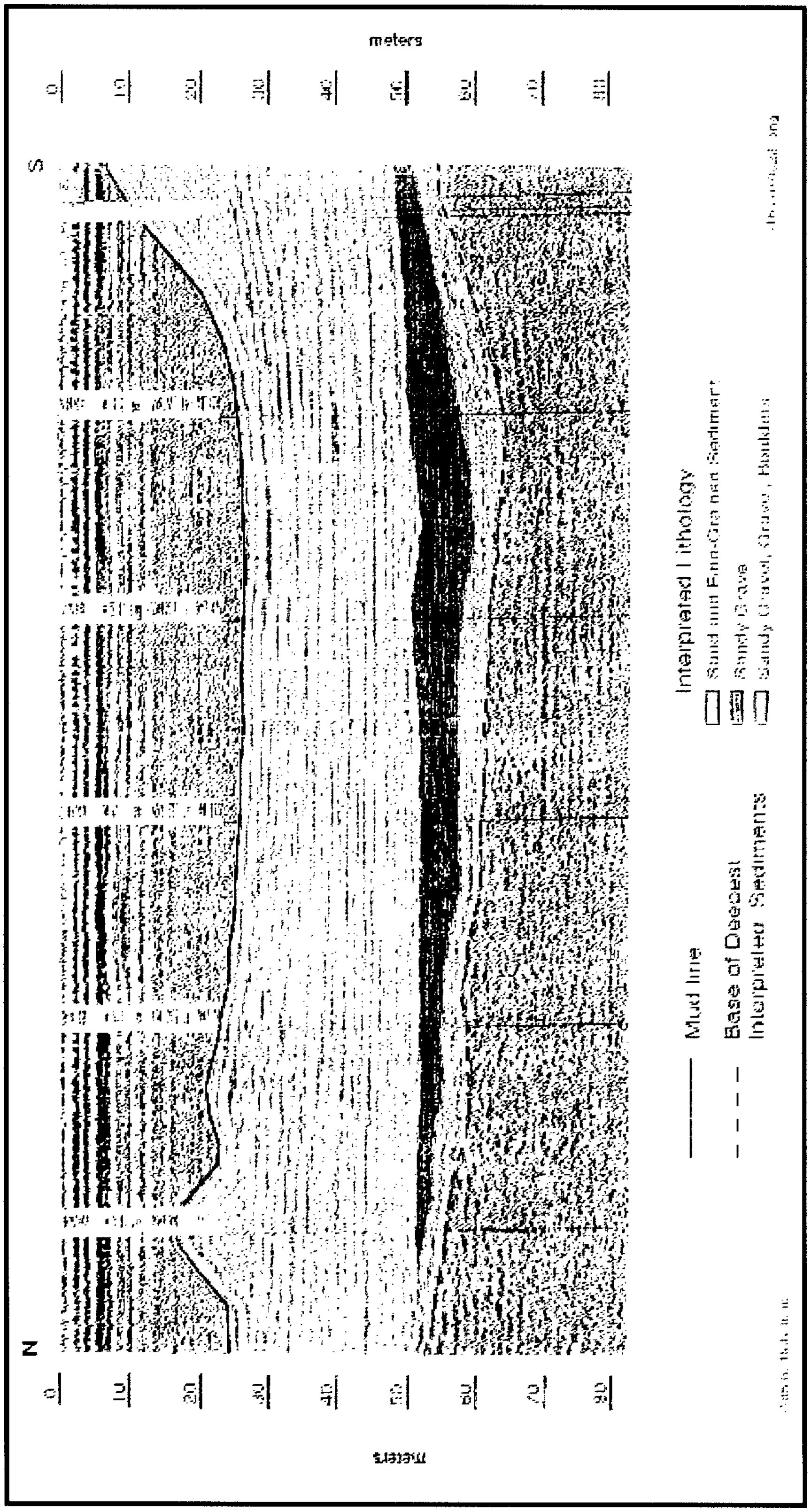



Figure 17. Geophysical survey at the head of Akutan Bay (from Shannon and Wilson 1998). Location of survey is shown in Figure 3

extends to about -50 m (-164 ft) msl (Figure 17). The geophysical cross section of Figure 17 indicates a coarsening of texture with depth. At the base of the seismic cross section, gravel and boulders are identified. This interpretation is consistent with boring data from alluvial valleys world wide. It is expected that the sediments above the rock contact are coarse-grained, similar in composition to the coarse basal sediments identified near the base of the geophysical profile.

# 4 Hydrology

## Climate

Akutan Island has a maritime climate characterized by cool summers and mild winters. Dutch Harbor, located approximately 64.4 km (40 miles) southwest of Akutan Island, is the closest weather station where long-term climate data are available. Table 3 summarizes monthly and annual temperature and precipitation data from Dutch Harbor for the past 49 years. Annual maximum and minimum temperatures are 45.7 and 35.3 °F, respectively. Total annual precipitation is nearly 152.4 cm (60 in.) of rainfall and 223.5 cm (88 in.) of snow fall. It is expected that Akutan Island has a climate history similar to that of Dutch Harbor because of its proximity.

## Surface Water

### Drainage basin

Surface drainage in the study area is defined by the drainage basin and the creek by which it flows to Akutan Bay (Figure 18). South Creek forms the smallest watershed (Figure 19). The bulk of the study area is located in the central drainage unit (Figure 20) and is the area most impacted by the proposed harbor construction. The central marsh area is drained by Central Creek. Only a small portion of the marsh area drains to North Creek (Figure 21).

The central area contains several small lakes which appear to be present year-round (Figure 20). The northern limit of the central basin begins along an east-west line, beginning at a point along the western valley wall and extending nearly due east to a point north of the mouth of Central Creek (Figure 18). The drainage divide between the northern and central units is clearly visible on the 1983 photograph. South of this line, the drainage flows to Central Creek (Figure 20). North of this boundary, marsh drainage flows to North Creek via a single small channel (Figure 21). This channel follows the edge of the prominent terrace (Figure 8) and enters North Creek at the eastern terrace edge. At this location, the stream has created a small waterfall as it descends to the level of North Creek (Figure 21b). The waterfall is clear evidence of the magnitude of recent uplift and stream dissection by North Creek.

**Table 3**
**Monthly and Annual Climate Summary of Temperature and Precipitation for Dutch Harbor, Alaska (502587). Period of Record from 1/1/1951 to 7/31/2000 (To convert inches to centimeters, multiply by 2.54)**

| Item | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Max Temp (°F) | 36.5 | 36.7 | 39.0 | 40.4 | 46.1 | 51.5 | 56.8 | 58.8 | 53.8 | 47.2 | 42.6 | 39.0 | 45.7 |
| Avg Min Temp (°F) | 27.5 | 26.5 | 27.9 | 30.8 | 36.4 | 41.4 | 45.8 | 47.3 | 42.8 | 36.7 | 31.3 | 29.8 | 35.3 |
| Avg Total Precip (in.) | 7.10 | 6.15 | 6.18 | 3.28 | 3.69 | 2.53 | 1.98 | 2.72 | 5.53 | 6.71 | 5.95 | 8.05 | 59.88 |
| Avg Total Snow Fall (in.) | 23.6 | 21.3 | 16.2 | 6.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 4.7 | 15.1 | 88.0 |

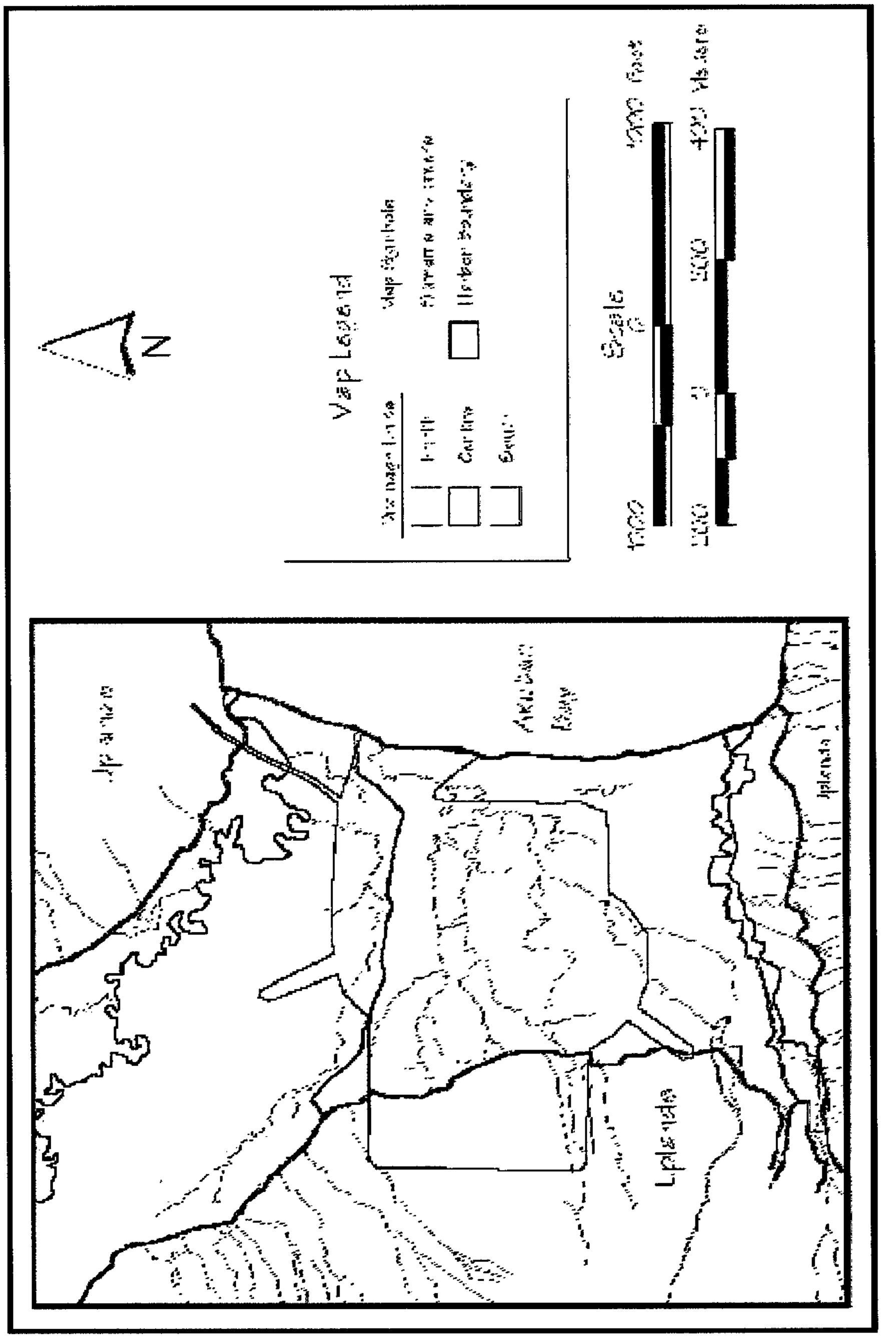
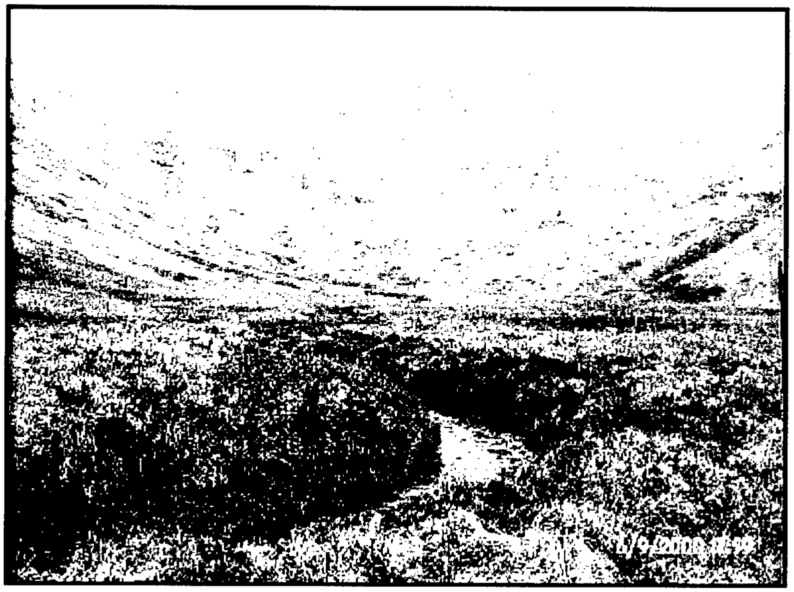
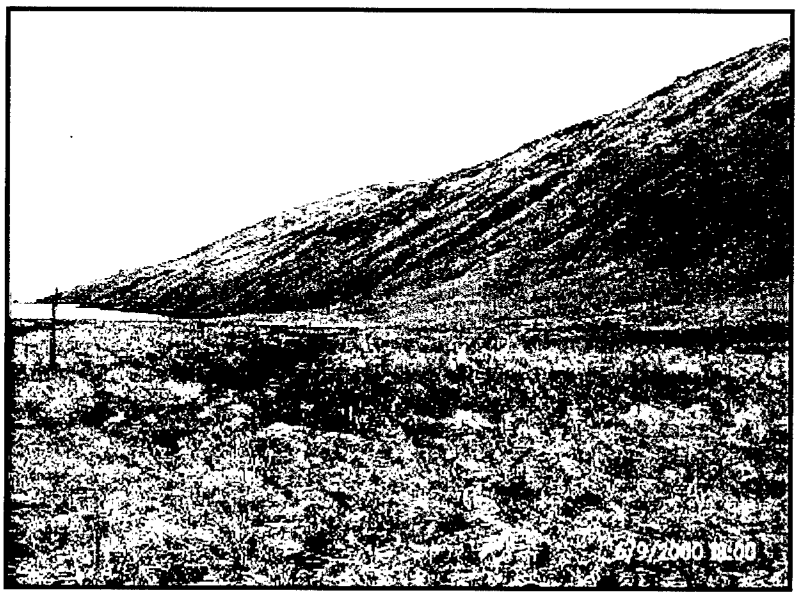


Figure 18. Drainage basins in study area

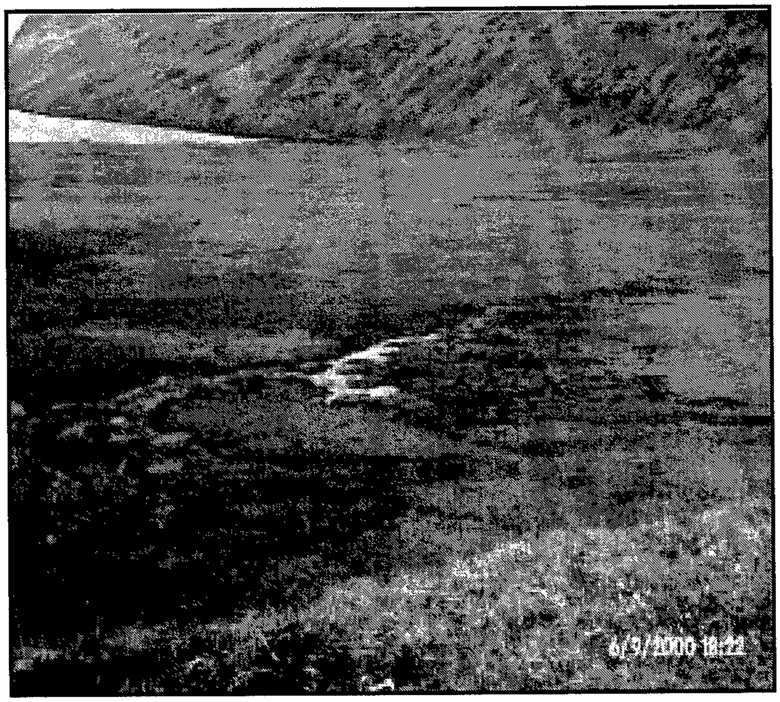


a. View of South Creek watershed looking upstream or southwest

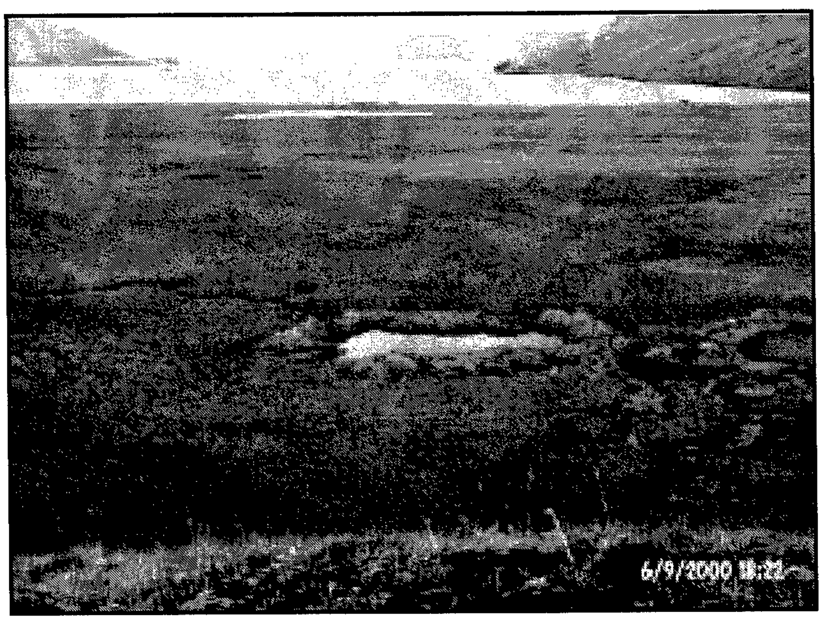


b. View of South Creek watershed looking down stream or southeast

Figure 19. South Creek watershed (courtesy of U.S. Army Engineer District, Alaska) is the smallest watershed on Akutan Island

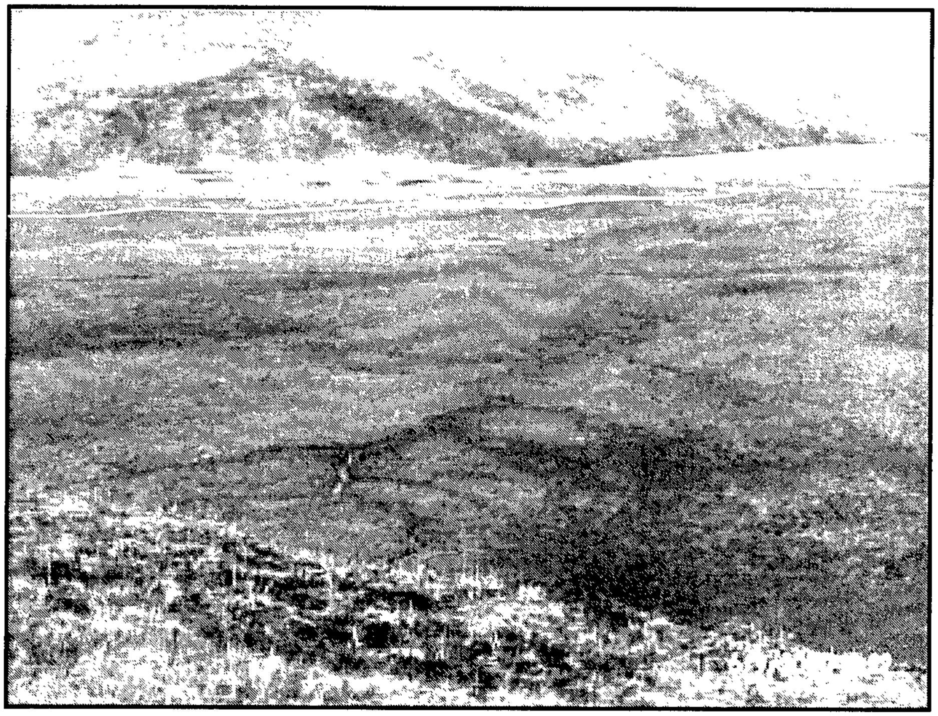



a. Central basin area, view toward southeast

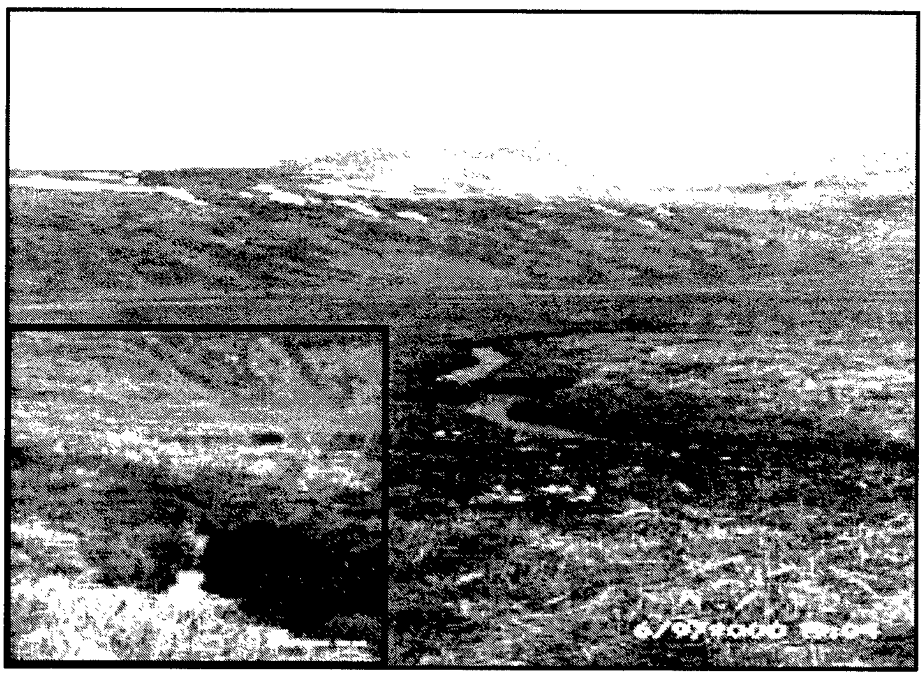



b. Central basin area, view toward east, Akutan Bay in background

Figure 20. Central drainage unit (courtesy of U.S. Army Engineer District, Alaska) is the area most impacted by harbor construction



a. Central and northern basin drainage units, yellow line approximate boundary between basins



b. View of stream draining northern basin marsh area. Inset photo on left shows waterfall where stream intersects floodplain of North Creek

Figure 21. Marsh area drainage to North Creek (photos courtesy of U.S. Army Engineer District, Alaska)

### Streamflow data

Temporary staff gages were installed at selected stream locations in North Creek (Figure 4). Water level measurements (Appendix B) at these gages were made to calibrate stream elevations to water elevations in the wells in order to determine groundwater flow directions and develop a groundwater contour map. Discharge or stream flow measurements were not performed during this study.

However, streamflow measurements were performed by Peratrovich and Nottingham (1982) for the earlier harbor study. These measurements are considered to be representative of drainage conditions encountered during the current study, because both field investigations were performed during August and there has been no significant change in stream locations. As shown by Table 3, July and August are the months with the least rainfall. Precipitation reported for Dutch Harbor is 1.98 and 2.72 in. (5.03 and 6.91 cm) for July and August, respectively. During the field visit, both North and South Creeks were flowing and the water level did not vary significantly. Upland drainage to North Creek represents a significant component of the streamflow. A waterfall, present in the northwest corner of the study area, flowed continuously during the field work. Headwater streams are actively contributing to the total flow.

Peratrovich and Nottingham (1982) report discharge measurements of 0.1105 $m^3$/sec, (cms) (3.9 $ft^3$/sec (cfs)) for South Creek (82W-8) and 0.309 cms (10.9 cfs) for North Creek (82W-5) on 1 August 1982 (see Figure 3 for stream discharge locations). Along North Creek, a 24-percent increase in stream discharge is reported along a 366 m (1,200 ft) reach, indicating the magnitude of the groundwater contribution into North Creek. The streamflow changed from 3,950 gallons per minute, gpm; 14,952 liters per minute, lpm (8.8 cfs) at a point 366 m (1,200 ft) upstream of station 82W-4 to 4,892 gpm, 18,511 lpm (10.9 cfs, 0.309 cms) at station 82W-5. During the course of their 10-day monitoring period, the flow rate on North Creek varied between 0.190 and 0.309 cms (6.7 and 10.9 cfs).

Drainage measurements were made on marsh streams for the Peratrovich and Nottingham (1982) study. Discharge measurements were made in the central and northern basins at locations 82W-9 and 82W-10 (Figure 3). At these locations, discharge measurements were 0.0076 and 0.0085 cms (0.27 and 0.30 cfs), respectively.

## Groundwater

### Groundwater contour map

A contour map of groundwater elevations is presented in Figure 22 based on water level measurements obtained on 22 August 2000. The contour map reflects water level elevations from monitoring wells, stream gages, and elevations on marsh streams and ponds. The water level contours indicate the

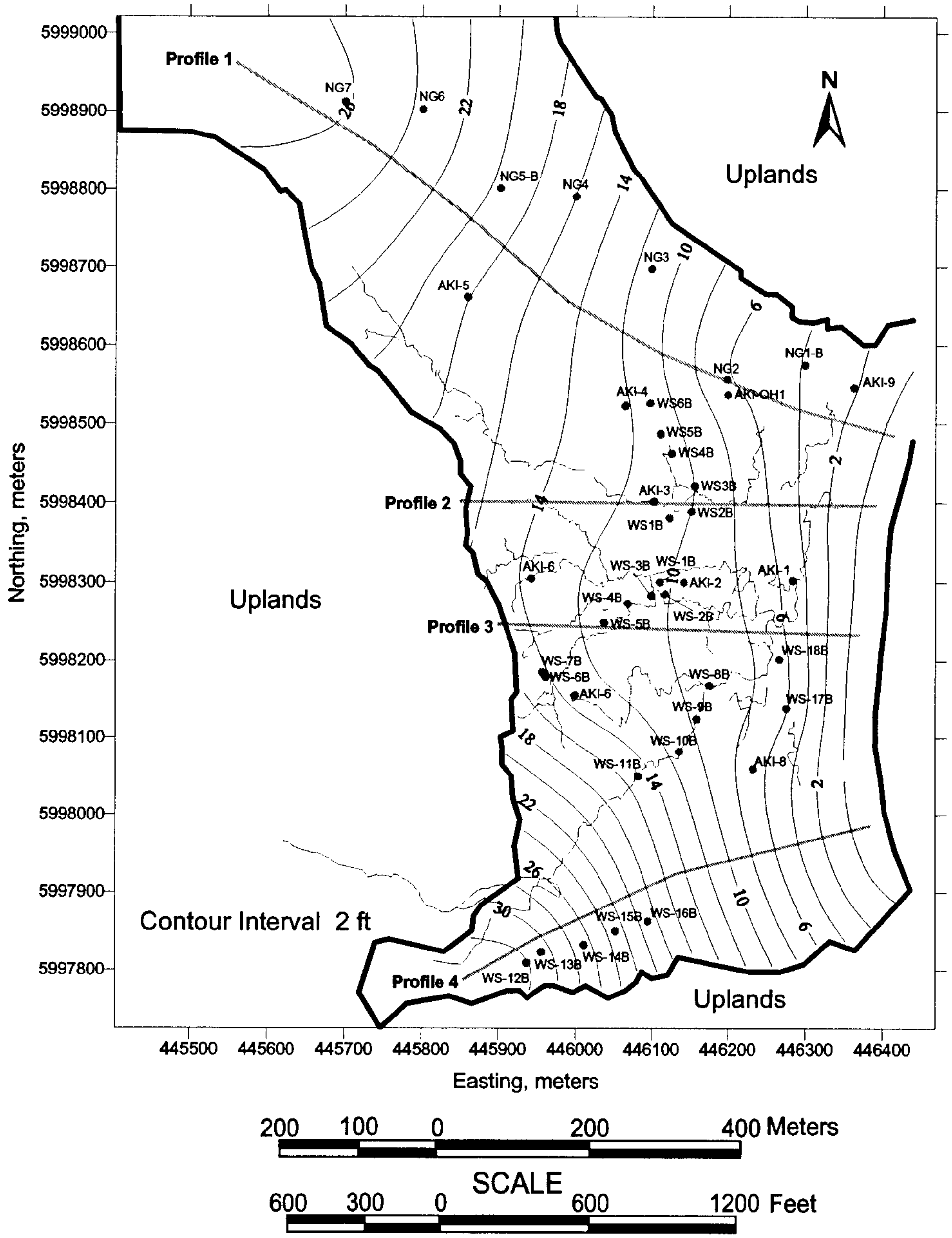



Figure 22. Contour map of water table from water level measurements made on 22 August 2000. Contour map based on water levels from wells, stream gages, and ponds. Contour interval is in feet msl. Map grid along border is in UTM (Zone 3, NAD 1983) with units in meters

direction of groundwater flow is to the east and toward the bay. The water table is shallow throughout much of the study area, generally between 0.6 and 0.9 m (2 and 3 ft) below ground surface. Standing water is common in much of the central marsh area. Most of the central marsh streams originate at the base of the western valley wall, where upland surface drainage collects and groundwater from permeable volcanic rocks and fractures is most likely in contact with the unconsolidated Holocene valley fill. Identified on Figure 22 are profile locations discussed in detail in Chapter 5.

## Aquifer type

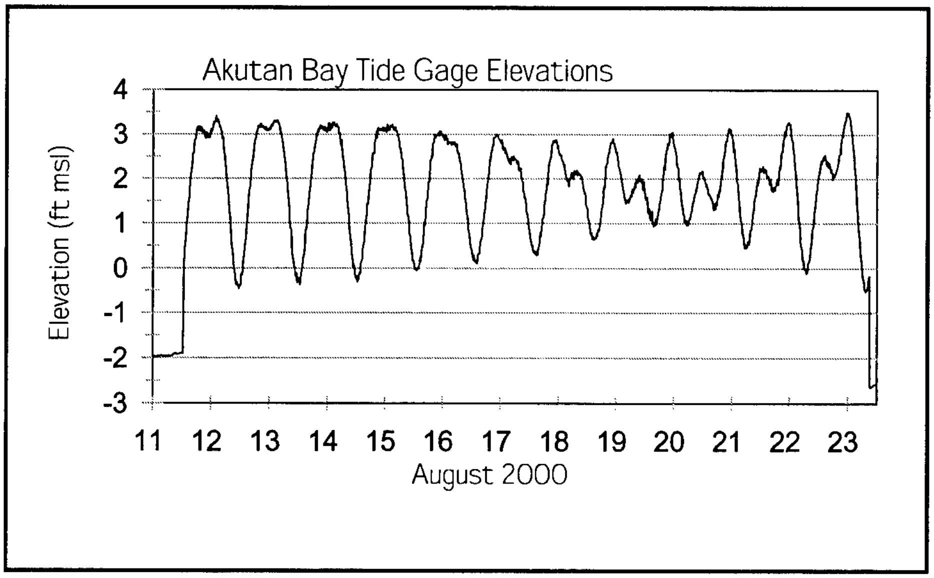
Boring and water level data identify a shallow, unconfined aquifer beneath the study area. Automated water level measurements in monitoring well AKI-1 define the unconfined nature of the water table as demonstrated by tidal variations that are present in the water level data. Graphs of water level elevations are presented in Figure 23 for a tide gage placed in Akutan Bay during this study and for monitoring well AKI-1. These curves show a variable range in water levels in both the tide and groundwater data in monitoring well AKI-1. For comparison purposes, the two charts are presented at similar graphical amplitudes in Figure 24 to show the correspondence between the groundwater and surface water for the period in common. The time required for the groundwater at well AKI-1 to respond to the tidal change varies from about 15 to 75 min. The maximum tidal range observed in Akutan Bay is approximately 1 m (3.4 ft) while the groundwater range measured in well AKI-1 is 0.086 ft (1.032 in. or 2.62 cm).

The magnitude of the change in bay level compared to the groundwater at monitoring well AKI-1 represents about a 40:1 relationship (i.e., 3.4/0.086 = 39.53) as shown by Figure 24. This 40:1 ratio supports the constant derived in the Ghyben-Herzberg equation for determining the depth to the fresh water/salt water interface. That is, a 0.3-m (1-ft) rise in sea level produces about a 0.008-m (1/40-ft) rise in the freshwater table. The Ghyben-Herzberg relationship is described in greater detail in the next section of this report. The values obtained for the ratio between the tide gage and monitoring well data further confirm the interpretation of an unconfined aquifer beneath the study area.

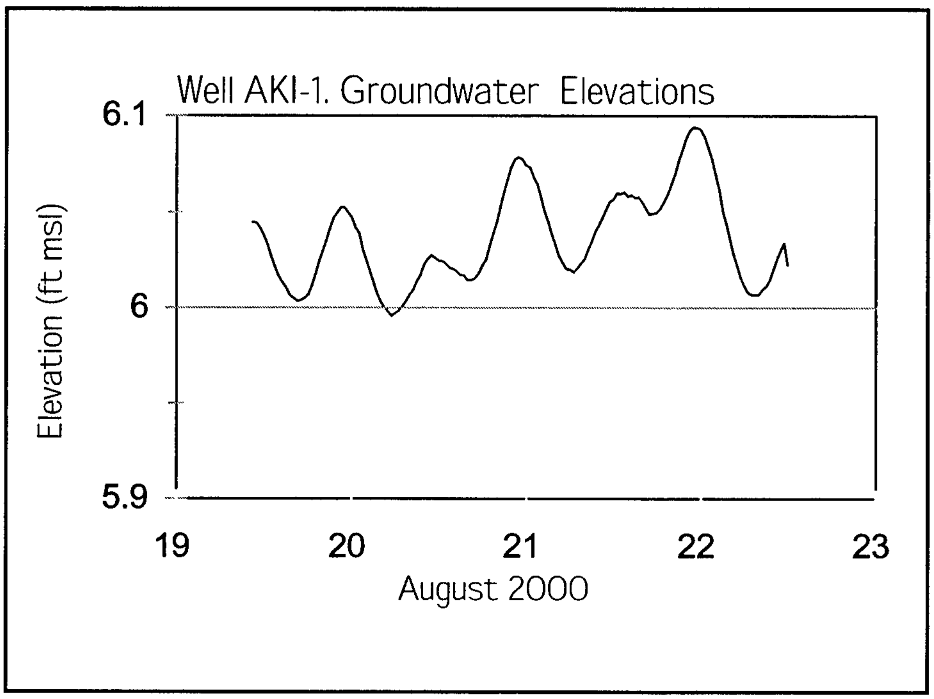
## Salinity

Salinity measurements were made on water samples obtained from monitoring wells and from various depths in Akutan Bay to characterize the salinity. Groundwater salinity was measured as part of the well installation process. Salinity of water samples obtained from monitoring wells was measured with an Oakton hand-held, total dissolved solid (TDS) tester calibrated for a standard solution. All values obtained from these measurements identified the water table beneath the marsh as fresh water.

For Akutan Bay, salinity measurements were performed with a salt refractometer on water samples obtained from a location approximately 61 m (200 ft) offshore and midway in Akutan Bay. Samples were collected from the surface

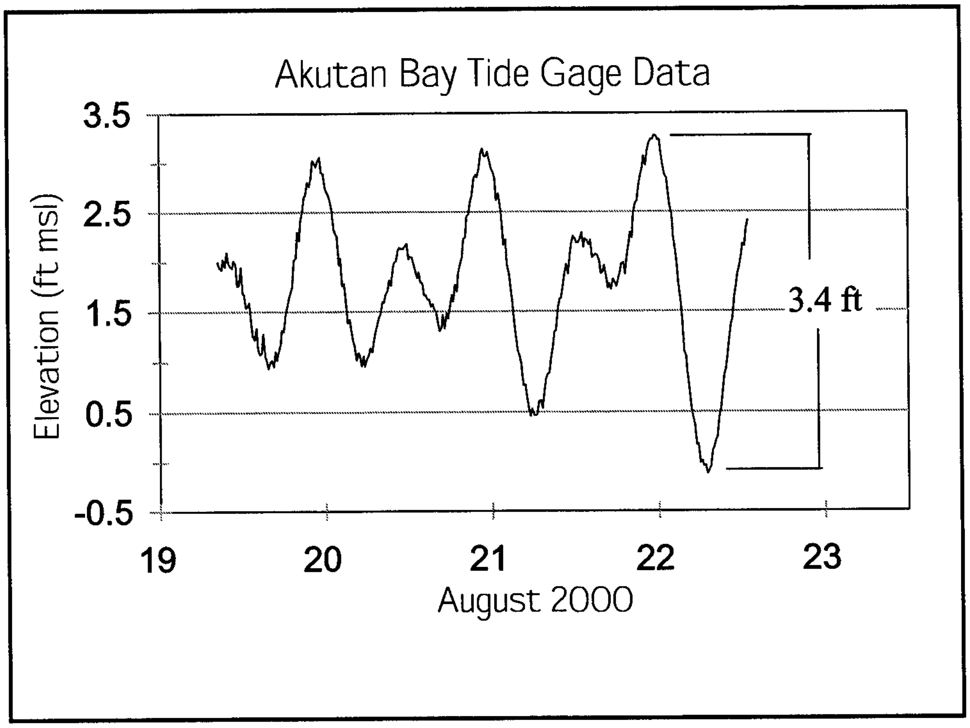



a. Tide gage elevations for Akutan Bay recorded every 15 min. Data from 12:00 AM, 11 August 2000 to 12:00 PM, 23 August 2000. Location of gage shown in Figure 4




b. Groundwater elevations in well AKI-1 recorded every 30 min. Water levels from 10:00 AM, 19 August 2000 to 1:00 PM, 22 August 2000

Figure 23. Graphs of water level elevations



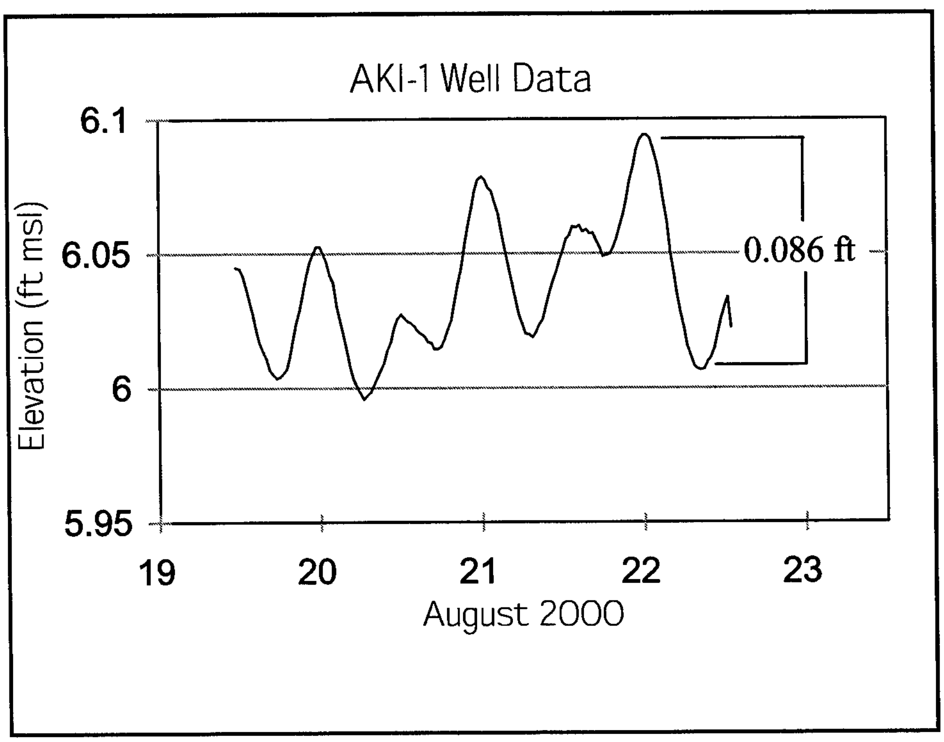




Figure 24. Comparison of tide gage elevations (upper graph) and water well elevations in monitoring AKI-1 (lower graph). Water level in monitoring well follows the tide by 15 to 75 min. The ratio between the two peaks is about a 40:1 difference

and at depths of 3.0, 7.6, 12.2 m (10, 25, and 40 ft, respectively). Salinity measurements for these samples ranged from 32 to 38 parts per thousand (ppt), representing a normal salinity range for seawater.

### Aquifer permeability and hydraulic conductivity

Permeability is the property or capacity of a sediment or soil to transmit fluid and it is a measure of the relative ease of fluid flow under unequal pressure (Bates and Jackson 1987). The permeability of the sediments comprising the valley fill in the study area is influenced by their texture or grain size and their degree of compaction. A measure of the permeability of sediments is generally expressed as hydraulic conductivity or coefficient of permeability, $\boldsymbol{k}$, and is the rate of flow of water (V/T, V=Volume, T=Time) through a cross section of one square unit ($L^2$, L=Length) under a unit hydraulic gradient at the prevailing temperature, generally adjusted for a temperature of 60 °F (Bates and Jackson 1987). Units of k are L/T, for example, $\frac{ft^3/\sec}{ft^2} = ft/\sec$.

Hydraulic conductivity ($\boldsymbol{k}$) of the aquifer can be estimated from laboratory grain-size data, laboratory tests of soil samples, and measured in the field from slug tests. Hydraulic conductivity estimates derived from grain-size data are calculated from "Hazen's Approximation," which is based on sieve data and the $D_{10}$ particle size (Fetter 1994, Hough 1969). The formula for Hazen's Approximation is $\boldsymbol{k} = 100\,(D_{10})^2$, in which $\boldsymbol{k}$ = coefficient of permeability in centimeters per second and $D_{10}$ = effective particle size in centimeters (grain size for which 10 percent of the particles are finer).

Laboratory permeability testing procedures for granular soils are based on the "Constant-Head Method." This laboratory test method is described in detail in reference document EM 1110-2-1906 (HQDOA 1986).

Slug tests are performed in the field at the well. The test involves introducing into the well or removing from the well a slug of water or other equivalent mass (e.g., weighted pipe). Measurements are then recorded of the time and elevation of the water level until the water level has recovered to its pretest state. The use of automated pressure sensors makes this test easy to perform in the field.

The introduction of a slug into the well corresponds to a falling-head test, while the removal of a slug corresponds to a rising-head test. Hydraulic conductivity values for slug tests are then calculated from the time and water level data recorded by the pressure sensor. A software program that analyzes these data was used to calculate the hydraulic conductivity values for monitoring well AKI-1. Software used to analyze the Akutan slug test data is BRSLUG (Jones 1999), using the Bouwer and Rice method. Slug test results are presented in Appendix E. Details on the equations and assumptions made in the Bouwer and Rice method are presented in Bouwer and Rice (1976), Bouwer (1989), and Jones (1999).

Hydraulic conductivity values based on the various methods discussed are presented and compared in Table 4. Values obtained by these various methods are similar and consistent. The range in values is between $10^{-2}$ and $10^{-3}$ cm/sec, which corresponds to well sorted (or poorly graded) clean sands.

**Table 4**
**Comparison of Hydraulic Conductivity Values by Various Methods**

| Sample Number | Depth ft, t | USCS Texture | $D_{10}$ Size mm | Hazen's Eq.[1] cm/sec | Laboratory[2] cm/sec | Slug Test[3] cm/sec | Source[4] |
|---|---|---|---|---|---|---|---|
| BH-10-2 | 9.0 - 10.5 | SP | 0.11 | $1.21x10^{-2}$ | - | - | SW |
| BH-10-3 | 23.5 - 25.0 | SP | 0.135 | $1.82x10^{-2}$ | - | - | SW |
| BH-11-1 | 2.0 - 3.5 | SP | 0.108 | $1.17x10^{-2}$ | - | - | SW |
| BH-11-4 | 15.5 - 17.0 | SP | 0.08 | $6.4x10^{-3}$ | - | - | SW |
| BH-11-7 | 31.5 - 33.0 | SM | 0.05 | $2.5x10^{-3}$ | - | - | SW |
| 82G-11-1 | 2.5 - 5.0 | SP | 0.118 | $1.39x10^{-2}$ | - | - | PN |
| 82G-11-2 | 5.0 - 8.0 | SW | 0.11 | $1.21x10^{-2}$ | - | - | PN |
| 82G-9-3 | 4.0 - 5.0 | SW | 0.116 | $1.35x10^{-2}$ | - | - | PN |
| AKI-1 | 3.0 - 5.0 | SP | 0.115 | $1.32x10^{-2}$ | - | $1.06x10^{-2}$ F<br>$8.81x10^{-3}$ R | ERDC |
| AKI-4 | 4.5 - 5.0 | SP | 0.117 | $1.37x10^{-2}$ | - | - | ERDC |
| AKI-5 | 3.0 - 5.0 | SP | 0.32 | $1.02x10^{-2}$ | $1.3x10^{-2}$ | - | ERDC |
| AKI-7 | 3.5 - 5.0 | SP | - | - | $4.8x10^{-3}$ | - | ERDC |
| AKI-8-1 | 1.2 - 1.5 | SP | 0.117 | $1.37x10^{-2}$ | - | - | ERDC |
| AKI-8-3 | 4.5 - 5.0 | SP | 0.11 | $1.21x10^{-2}$ | $1.8x10^{-2}$ | - | ERDC |

[1]Hazen's Equation or Approximation: $k=100D_{10}^2$ in which k = coefficient of permeability in centimeters per second, $D_{10}$ = effective size in centimeters (Fetter 1994, Hough 1969).
[2]Laboratory methods: Constant Head Method, reference document EM 1110-2-1906 (HQDOA 1986).
[3]Slug tests performed on AKI-1; first value is falling head test (F), second value is rising head test (R). Hydraulic conductivity values derived from Bouwer-Rice Slug Test Analysis software (Jones 1999). See Appendix E or data on slug tests.
[4]Sources of data: SW = Shannon and Wilson 1998; PN = Peratrovich and Nottingham 1982; ERDC = data this study by ERDC.

# 5 Akutan Harbor Saltwater Encroachment Model

## Saline Water Encroachment

Actions of man that result in saline groundwater entering a freshwater aquifer are termed saline (salt-) water encroachment (Fetter 1994). Saltwater encroachment can be described as either passive or active. In passive encroachment, fresh water is displaced from an aquifer but the hydraulic gradient is toward the freshwater/saltwater boundary. The boundary slowly adjusts by moving landward as it reaches equilibrium. Usually, the effects of passive saline encroachment are minimal over a short period of time. Active encroachment involves reversal of the hydraulic gradient with fresh water moving away from the freshwater/saltwater boundary. This situation usually results from pumping a large volume of groundwater in a concentrated area leaving a deep cone of depression. The boundary shifts rapidly in order to reach equilibrium. At Akutan, recharge occurs by runoff of freshwater from the surrounding uplands into the bay. The fresh water "flushes" the salt water to greater depths as a result of hydrostatic equilibrium. A saltwater "wedge" forms, decreasing in thickness inland.

## Freshwater/Saltwater Interface at Akutan Harbor

The groundwater environment at Akutan Bay supports a single layer system consisting of an unconfined aquifer, herein referred to as the Akutan aquifer. Two subsurface flow regimes are recognized within the Akutan aquifer; shallow fresh water and deep salt water, separated by an interface of brackish water. In reality, the freshwater/saltwater interface or boundary is of a finite thickness with salinity of the transitional zone increasing with depth. However, for modeling purposes, the boundary is portrayed as a sharp interface between fresh water and salt water. The interface is dependent on the volume of fresh water discharging from the aquifer, and, therefore, any change in the volume of fresh water alters its shape and position. Tidal fluctuations, climatic variations, and sea-level changes affect the boundary position by placing it in a state of quasi-equilibrium.

## The Ghyben-Herzberg Principle

A one-dimensional (1-D) model, based on the Ghyben-Herzberg principle, was developed to describe the position of the freshwater/saltwater interface at Akutan Harbor. The major purposes of the model were to determine the depth of the freshwater/saltwater interface and to predict the degree of saltwater encroachment after construction of Akutan Harbor. The relationship between fresh water and salt water in an unconfined aquifer was discovered by two researchers working independently in the late nineteenth century. The principle that describes this relationship bears the names of these scientists, W. Baydon-Ghyben and A. Herzberg, who noted that the depth to which fresh water extends below sea level is approximately 40 times the height of the water table above sea level. Application of this principle is limited to situations in which both the fresh water and salt water are static and flow is nearly horizontal. Near the shoreline, vertical flow becomes pronounced and significant errors occur in the calculated depth to the interface (Todd 1980). Because the water table is in continuous motion near the shoreline, the freshwater/saltwater system is not in equilibrium, and the Ghyben-Herzberg relationship does not strictly apply. In the absence of precise data on aquifer permeabilities, flow velocities and directions, and direct measurements of the interface depth, Ghyben-Herzberg permits at least an approximation of the position of the interface.

The equation that supports this principle is as follows (Fetter 1994);

$$z_{(x,y)} = \frac{\rho_w}{\rho_s - \rho_w} h_{(x,y)} \tag{1}$$

where

$z_{(x,y)}$ = depth to the saltwater interface below sea level at location

$h_{(x,y)}$ = elevation of the water table above sea level at point

ñ$_w$ = density of fresh water (g/cm$^3$)

ñ$_s$ = density of salt water (g/cm$^3$)

Equation 1 is derived from the observation that a hydrostatic balance exists between salt water and fresh water in a U-shaped tube as shown in Figure 25. Pressure on each side of the tube must be equal, so that

$$\rho_s g z_{(x,y)} = \rho_w g \left( z_{(x,y)} + h_{(x,y)} \right)$$

where

g = acceleration due to gravity (m/s$^2$)

Solving for $z_{(x,y)}$ yields Equation 1.

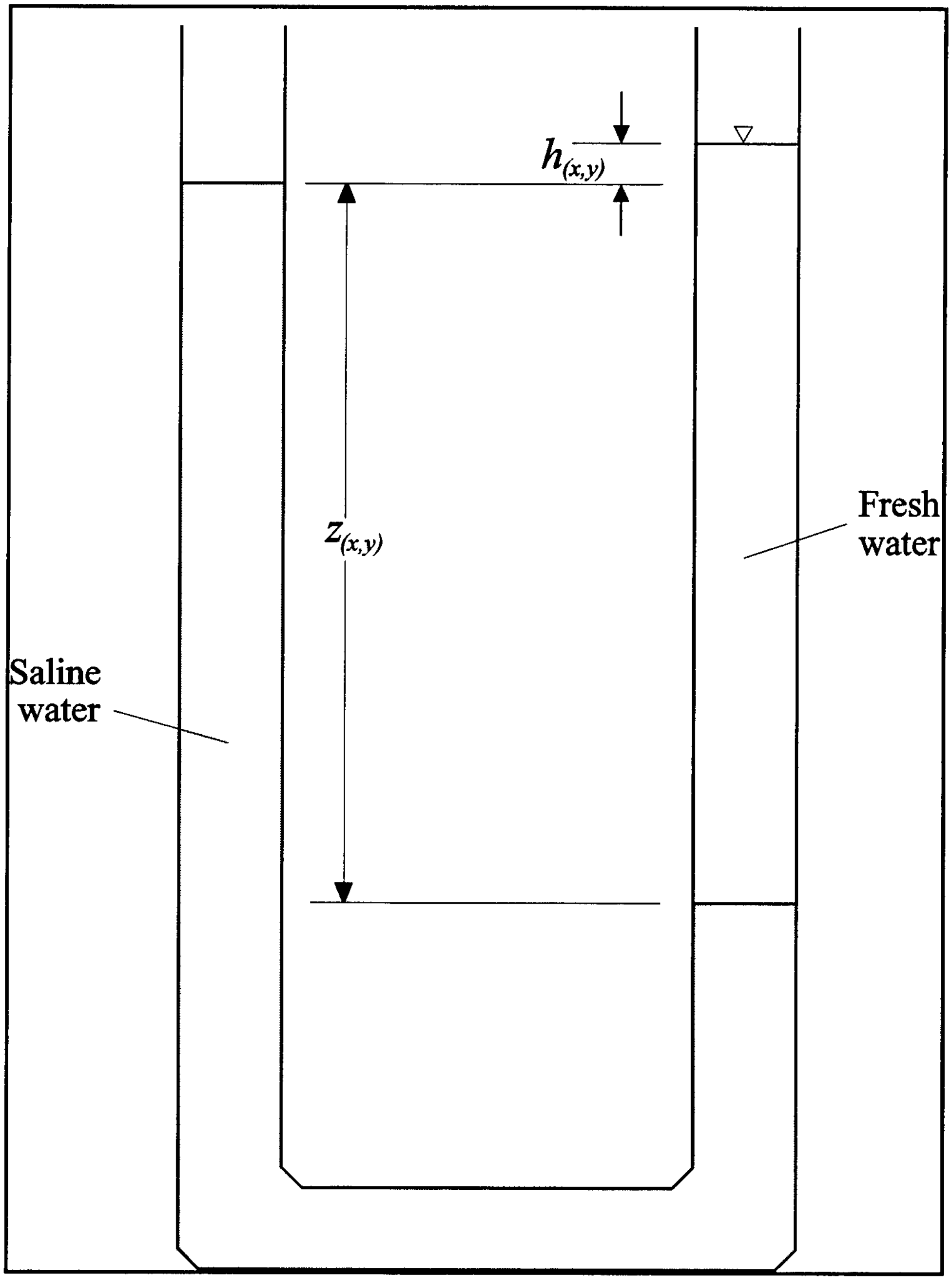



Figure 25. Hydrostatic balance between fresh and saline water in a U-shaped tube (after Todd 1980)

Typical saltwater and freshwater densities are 1.025 g/cm$^3$ and 1.000 g/cm$^3$, respectively. Using these values in Equation 1 yields the relationship

$$z = 40h_{(x,y)} \tag{2}$$

meaning that the depth to the freshwater/saltwater interface is 40 times the height of the fresh water above sea level. Knowing the elevation of the (fresh) water table at any point allows a determination of the approximate depth to the interface at that point using the Ghyben-Herzberg principle.

# Groundwater Models

## Model review and considerations

Several groundwater models were examined and evaluated for this investigation. The primary purpose of a groundwater model is to predict the position of the freshwater/saltwater interface beneath the proposed Akutan Harbor and to determine the physical environmental impacts due to harbor construction. A major consideration for the selection of a groundwater model for this study is the ability to simulate saltwater encroachment, rather than saltwater intrusion from aquifer pumping.

The USGS provides a public domain software package, SHARP, released in 1990. SHARP is a quasi-three-dimensional (3-D) finite difference model used to model a multiple aquifer system separated by confining layers. SHARP uses the vertically integrated freshwater and saltwater flow equations for each aquifer coupled with the boundary condition at the freshwater/saltwater interface.

The public domain version of SHARP requires a Lahey Computer Systems Incorporated 32-bit FORTRAN compiler F77L-EM32. However, the International Ground Water Modeling Center in Golden, CO, has a license to market a version of the software with stand-alone executables, thus eliminating the need for a separate compiler. Downsides of SHARP are the slow execution of the program and the lack of convergence (i.e., the time-step must initially be small).

Another code, MOCDENSE, was modified from an existing USGS program. MOCDENSE, a two-dimensional (2-D) model, is based on the finite-difference method and computes changes in concentration over time. It is usually used in investigations of saltwater intrusion and contaminant migration.

The Department of Defense Groundwater Modeling System (GMS) is a complex groundwater-modeling environment that supports models applicable to a variety of groundwater investigations. The computer space and time required to build a model using GMS modules put GMS use outside the scope of most small-scale studies.

Besides the problems of these different models addressing intrusion rather than encroachment, data requirements imposed by the different software packages reviewed restricted the predictive tools for the Akutan Harbor to a 1-D model. A 2-D or 3-D model, while serving as a more accurate predictive tool, would require a greater amount of input data than were available in the Akutan Harbor investigation. Thus, a 1-D model based on the Ghyben-Herzberg relationship and the water level measurements taken during the field investigation best approximates the representation of the saltwater wedge.

### Development of a 1-D saltwater interface model

Data for the 1-D saltwater interface model consist of northings, eastings, and elevations (X, Y, and Z coordinates) of water level readings measured in wells and streams in the Akutan Harbor area. These data were compiled in a Microsoft Excel spreadsheet and imported to Golden Software's Surfer 7 for gridding and contouring. Elevations of the freshwater/saltwater interface were computed from freshwater elevations using the Ghyben-Herzberg relationship and stored in a separate Excel worksheet column. Contouring grids were then calculated for the water table and the saltwater interface elevations using Surfer 7's radial basis function interpolation method, multiquadratic option. Contour maps of elevation were constructed from the water table and saltwater interface grids in Surfer 7's contouring utility.

The radial basis interpolator produces contours similar in appearance to manually constructed contours and is mathematically analogous to the kriging interpolation method. The gridding routine first superimposes a rectangular grid of points on the original data points and then calculates z values (in this case elevation) to produce the contour map. Grids were bounded using the "fault" feature of Surfer, whereby a polygon defined by the user limits gridding to the area within the polygon. In this case, the fault polygon delimited the relatively flat basin defined by the base of the uplands to the north, south, and west, and by the ocean, or bay, to the east. Gridding and contouring were limited to the interior of the fault-bounded polygon.

Four vertical profiles were constructed trending east to west to represent the saltwater wedge in the subsurface at various locations in the study area (see Figure 22 for location). These profiles were created with Surfer's "Slice" utility and then displayed using the graphing capability in Excel 97. "Slice" uses an algorithm that records the northing, the easting, and the elevation of the water table or saltwater interface at every intersection of the profile line with the calculated grid. These points are then used to construct the profile.

# Model Results

## Present conditions

Groundwater contour maps of the Akutan Harbor area summarize the results of this study. These maps reflect conditions during the time of the field work from measured values of water levels in wells and gages, and calculated values of the freshwater/saltwater interface by application of the Ghyben-Herzberg principal in the Akutan Harbor area. A contour map of the water table was presented previously as Figure 22 for water elevations measured in wells and stream gages on 22 August 2000. A contour map of the elevation of the freshwater/saltwater interface using the Ghyben-Herzberg relationship is presented in Figure 26.

Both contour maps in Figures 22 and 26 were created with a grid spacing (resolution) of 8 m (i.e., grid cell or node spacing is 8 m in width in the northing and easting directions). The boundary of the contoured area on both maps is a bold line, which defines the existing depositional basin surrounded by uplands and the sea. Identified on both contour maps are water level measurement points (wells, borings, and stream gages) and the locations of four vertical profiles constructed in "Slice."

The water table in Figure 22 reflects the surface topography of the basin as illustrated by the topographic map in Figure 27 (Berry and Graves 2000). The northern and southern arms of the basin (areas of profiles 1 and 4), Figure 22, show a monoclinal, uniform slope of the water table to the sea. The central basin (areas of profiles 2 and 3) is much flatter in the west-central portion and steepens toward the sea on the eastern side. The flattening of the water table in the central basin probably reflects ponding in the marshlands between the elevated relict beach near the shore and the uplands to the west (see discussion of geology and geomorphology in Chapter 3).

The shape of the freshwater/saltwater interface contours in Figure 26 mimics that of the water table because the interface is a multiple of the water table according to Equation 2 (i.e., $z = 40h_{(x,y)}$). Water table elevations range from 9.8 m (32 ft) msl in the southwest corner of the basin to zero at the shoreline.[1] Elevations of the freshwater/saltwater interface calculated by the Ghyben-Herzberg model ranged from about -365.8 m (–1,200 ft) msl in the southwest corner to zero.

Four vertical profiles in Figures 28 through 31 show the shape of the water table and freshwater/saltwater interface in cross section at various profile locations identified on both Figures 22 and 26. The profiles show the "wedge" defined by the water table and saltwater interface. Relatively large undulations in the profile at the saltwater interface reflect small variations in water table elevations because of the multiplying factor of the Ghyben-Herzberg relationship discussed above. The flattening of the central portion of the slope of the

[1] A value of 0 was assigned to shoreline elevation. Tidal fluctuations actually produced elevations above an MSL of 0.

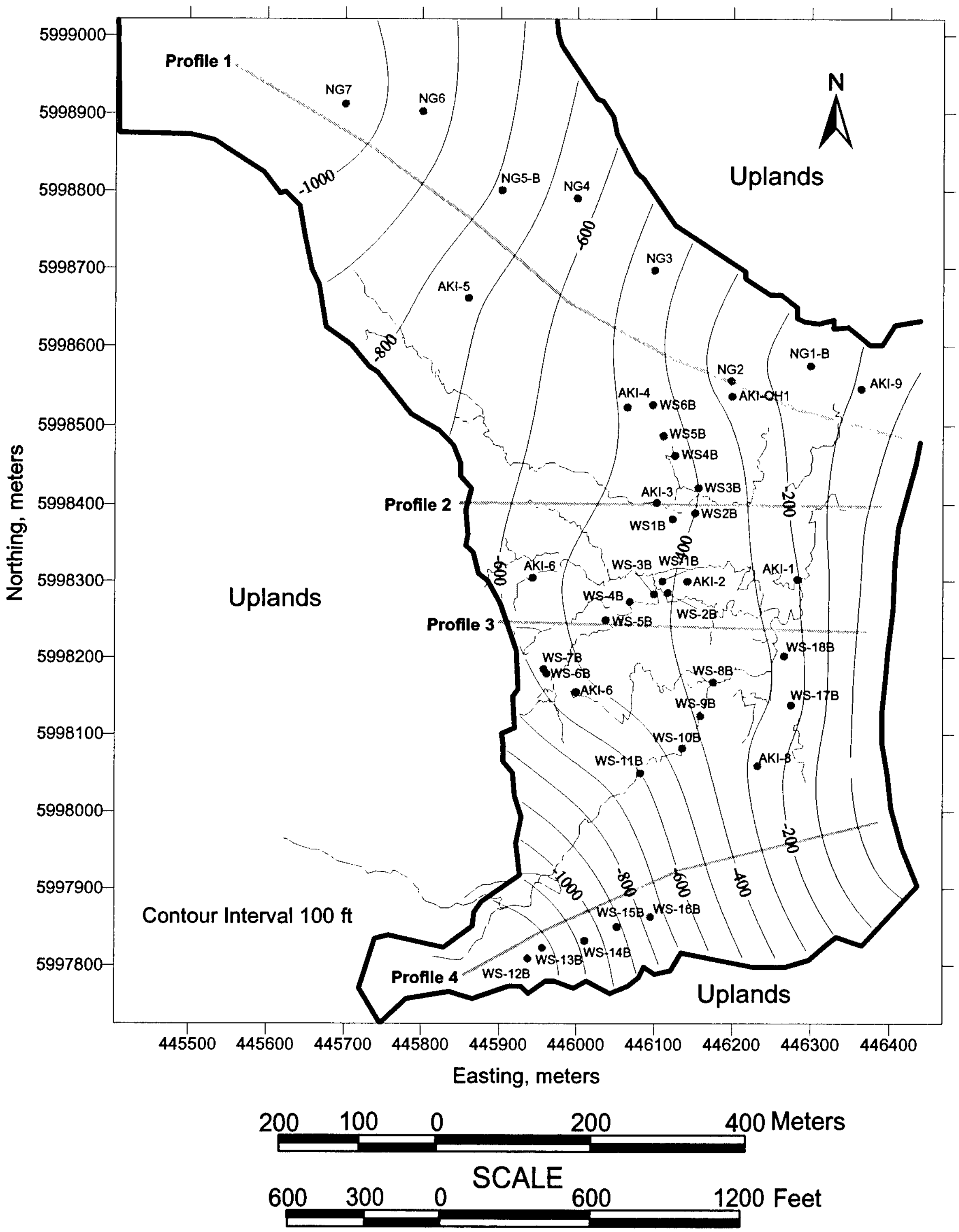



Figure 26. Contour map of the saltwater interface based on water level measurements made on 22 August 2000 and application of the Ghyben-Herzberg Principle. Contour interval is in feet msl. Map grid along border is in UTM (Zone 3, NAD 1983) with units in meters

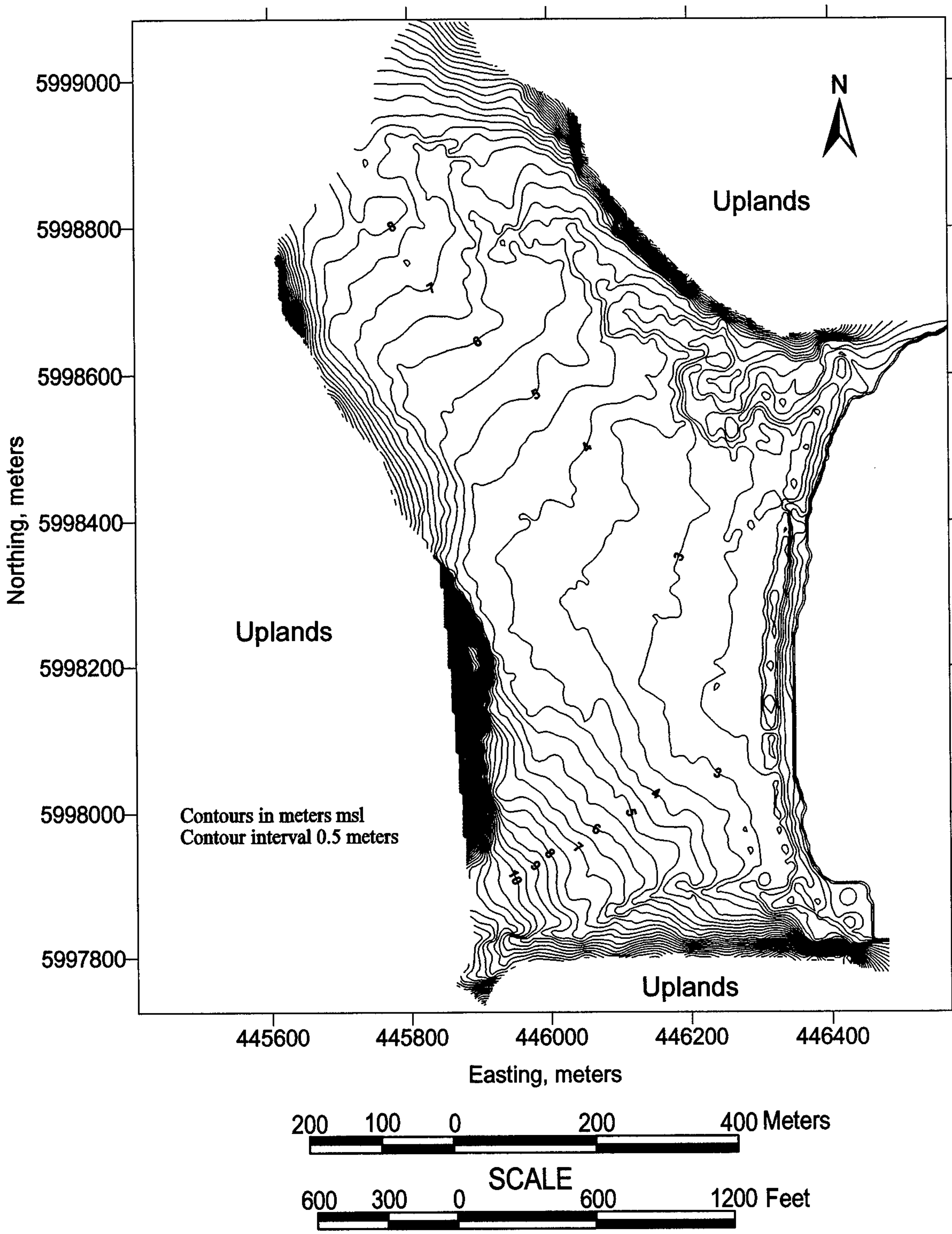



Figure 27. Topographic map of Akutan Harbor study area showing elevation of the ground surface (Berry and Graves 2000). Contour interval of map is in meters. Map grid along border is in UTM (Zone 3, NAD 1983) with units in meters

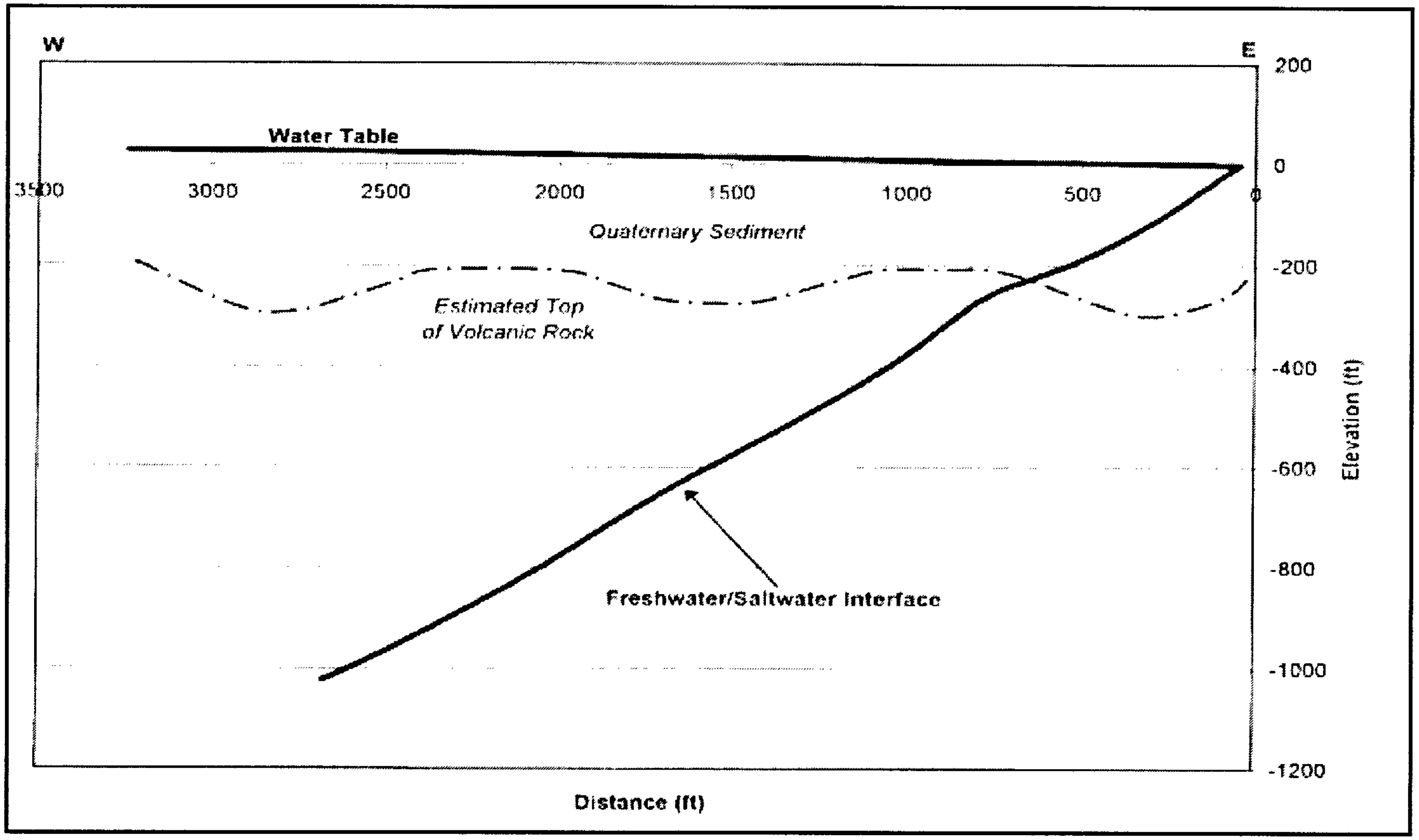



Figure 28. Profile 1 showing the water table and saltwater interface beneath Akutan Harbor study area. Profile extends west from shoreline (see Figures 22 and 26 for profile locations) (To convert feet to meters, multiply by 0.3048)

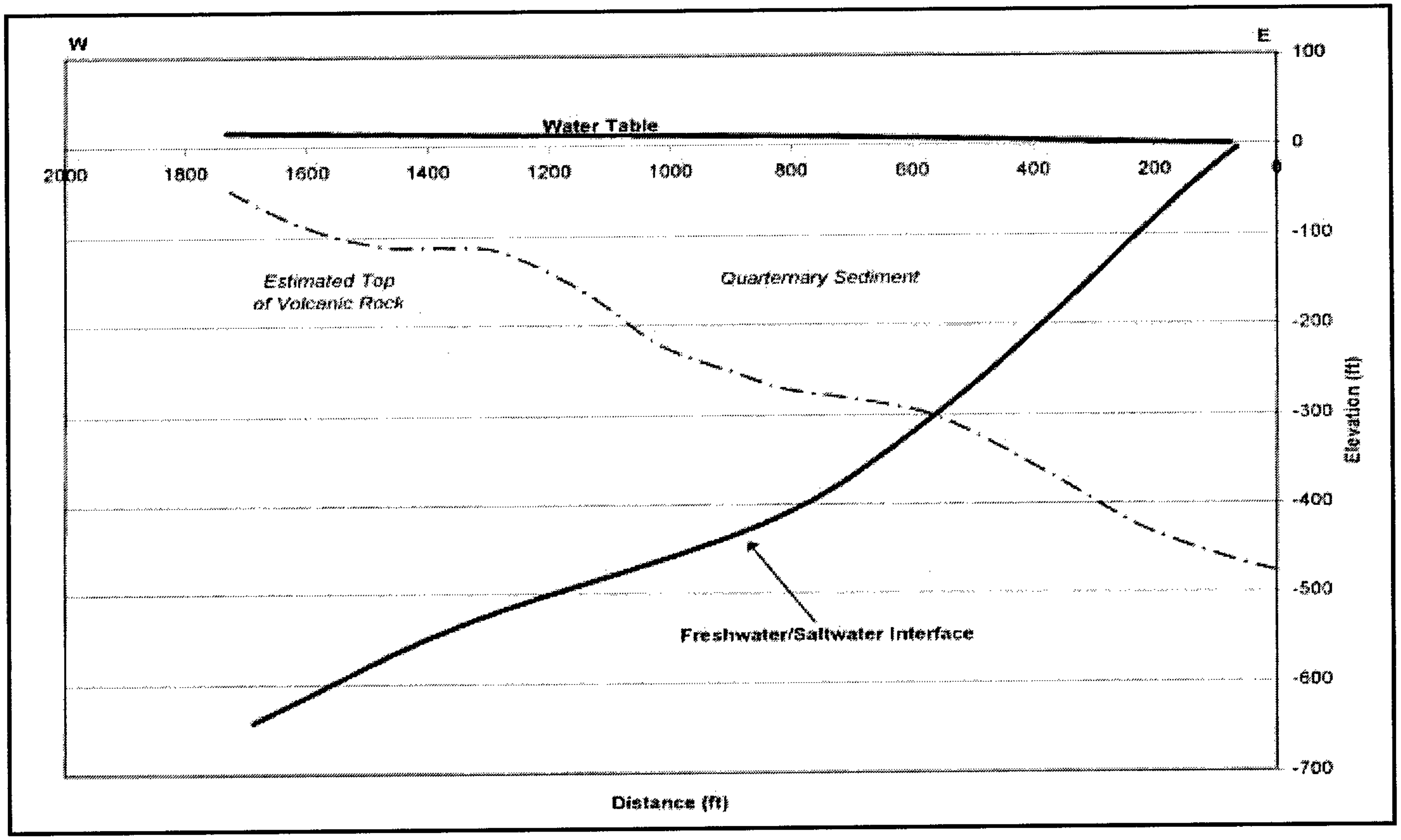



Figure 29. Profile 2 showing the water table and saltwater interface beneath Akutan Harbor study area. Profile extends west from shoreline (see Figures 22 and 26 for profile locations) (To convert feet to meters, multiply by 0.3048)

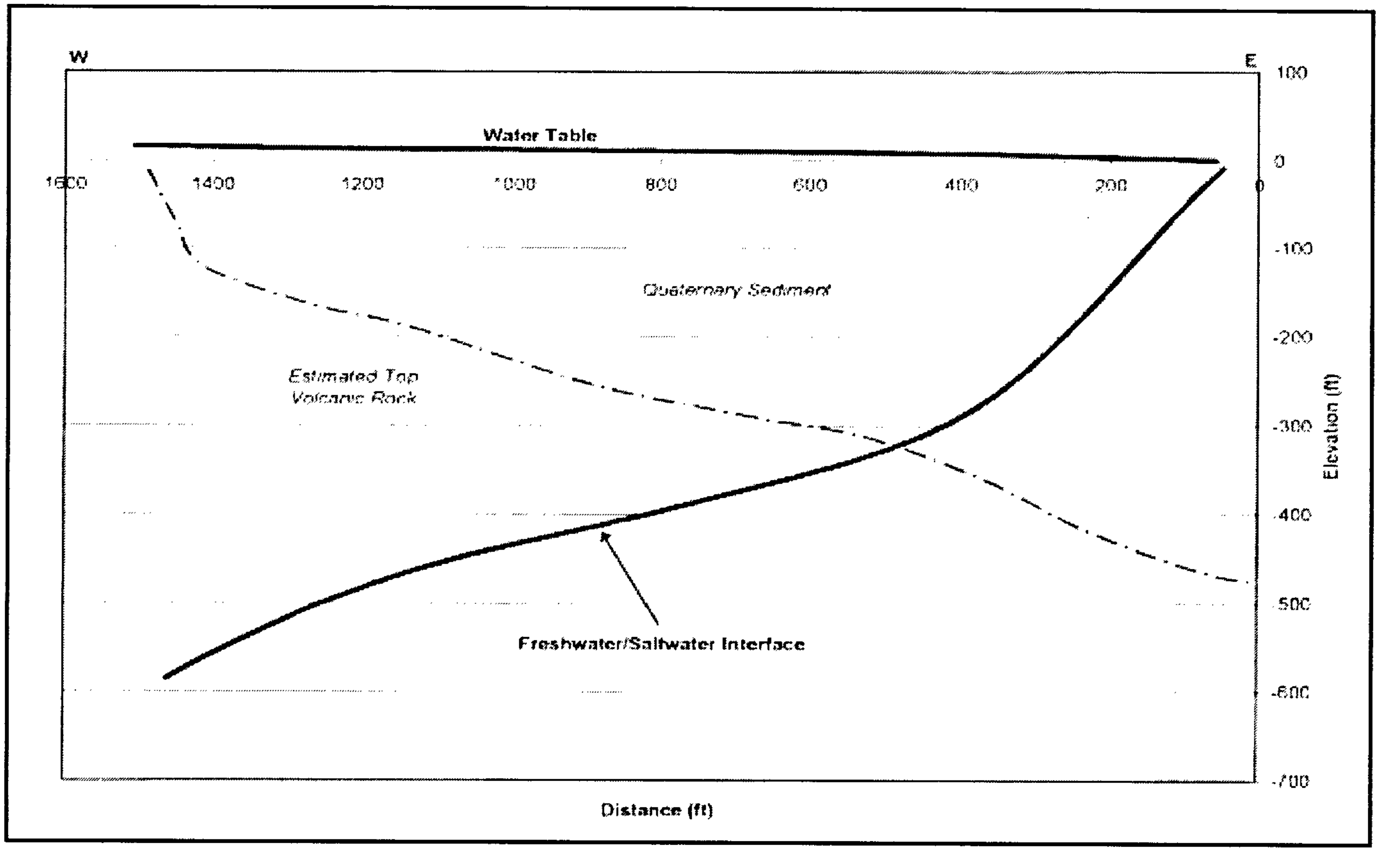



Figure 30. Profile 3 showing the water table and saltwater interface beneath Akutan Harbor study area. Profile extends west from shoreline (see Figures 22 and 26 for profile locations) (To convert feet to meters, multiply by 0.3048)

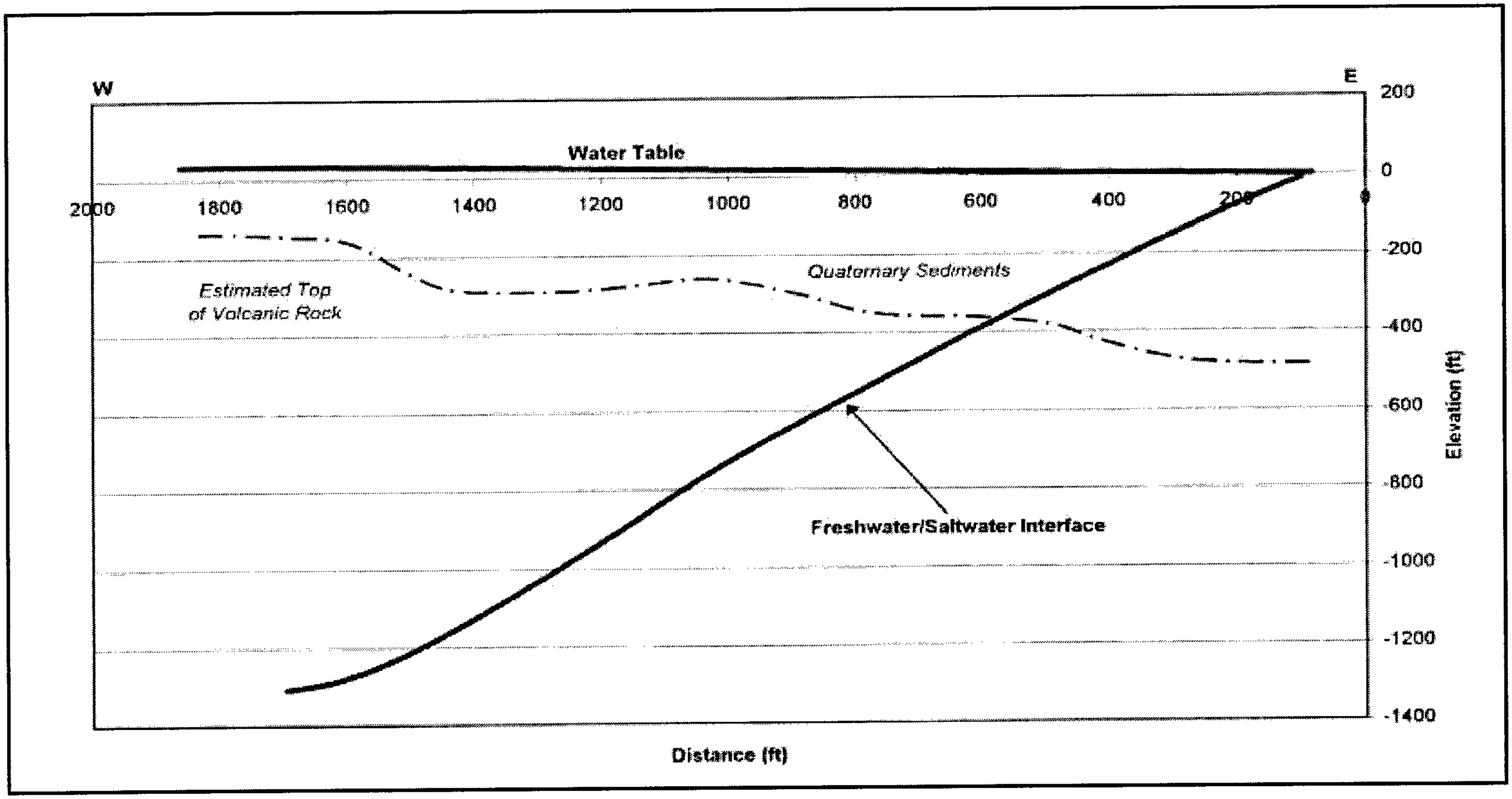



Figure 31. Profile 4 showing the water table and saltwater interface beneath Akutan Harbor study area. Profile extends west from shoreline (see Figures 22 and 26 for profile locations) (To convert feet to meters, multiply by 0.3048)

saltwater interface in profiles 2 and 3 is a result of the ponding of surface water in the marshlands. Figures 28 through 31 also show the approximate position of the top of volcanic rock underlying the Quaternary sediments of the Akutan Harbor area. The position of the top of rock-sediment boundary was estimated from the projected slope of the surrounding topography. The estimated top of rock is shown to highlight the fact that the saltwater/freshwater interface probably extends into the underlying fractured and permeable volcanic rock.

### Effects of proposed harbor construction

The following discussion addresses the impacts caused by the maximum harbor outline originally proposed. The latest harbor plan as of April 2001 calls for a significantly smaller harbor footprint (Figure 2) with reduced impacts to the marsh area and the surface hydrology.

The maximum proposed expansion of Akutan Harbor will extend the shoreline inland approximately 640 m (2,100 ft) for a width of about 396.2 m (1,300 ft) north and south, effectively cutting the basin in two. Figure 32 is a map of the basin with the approximate outline of the proposed expansion superimposed. The expansion will remove much of the marsh and marsh sediments that currently exist in the central portion of the basin. There are a number of potential effects on the hydrology of the basin that may result from harbor expansion. The effects cannot be absolutely quantified with the available information and models, but are discussed qualitatively.

Harbor expansion potentially will affect the freshwater table in several ways. First, the shape of the water table surface will be altered. The shoreline will be extended inland and will impose a new base level in the interior of the basin. Groundwater and surface water that now flow and discharge to the eastern shoreline will enter the sea to the south and north. The establishment of a new base level will shorten the flow path and steepen the gradient.

To simulate the effects of harbor construction, the authors recontoured the water table elevations using the maximum proposed harbor shoreline. The data set of existing water measurements was first divided into separate north and south data sets. Each data set was then gridded and contoured separately in Surfer using fault polygons defined by the remaining basin boundary and the proposed harbor expansion. The separately contoured maps were combined into a single map to show the configuration of the water table. The newly configured contours are shown in Figure 32. Because the actual elevations of the adjusted water table (after harbor expansion) are unknown, and because the existing water table elevations were used in the contouring, the contour values have been omitted in Figure 32. Assuming freshwater levels will adjust equivalently throughout the basin following harbor expansion, the shape of the water table would be independent of actual water levels. The obvious effect of harbor expansion shown by Figure 32 is the diversion of freshwater to the south from the northern uplands and to the north from the southern uplands, shown by the bold flow lines.

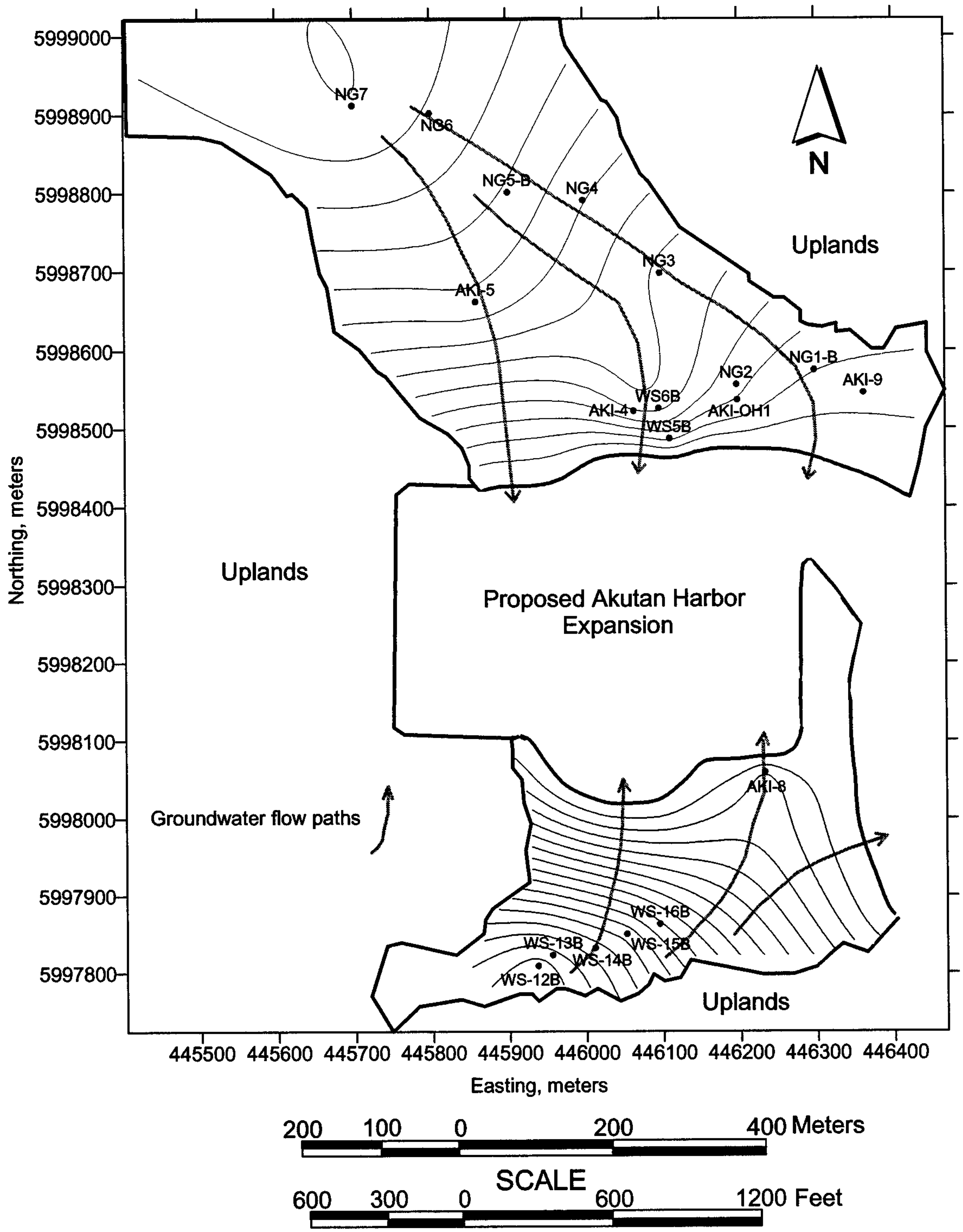



Figure 32. Predicted shape of water table after harbor expansion and expected flow lines. Contour values have been omitted (see text)

It is difficult to predict how the freshwater table will adjust following harbor expansion. Expansion will bring the sea further inland with an accompanying encroachment of the saltwater interface. Much of the existing marsh and the relict beach ridge will be removed, which will allow formerly trapped freshwater to escape directly to the sea. As a result, the remaining marsh would be expected to become more saline. The effect on the actual elevation of the freshwater table after equilibrium is established following construction is unknown. The elevation of the freshwater table will be directly dependent on the volume and flow rate of aquifer recharge into the basin. Currently, the water table is shallow throughout the entire study area and the underlying soils are relatively coarse-grained. It is likely that the water table will remain shallow, providing harbor construction does not alter the character of the headwaters, flow of the major streams, and aquifer recharge. A major unknown is the quantity of recharge that occurs along the western edge of the central basin from fractures in the volcanic uplands in contact with the Holocene basin fill. Excavation and partial removal of the western valley wall may possibly impact fracture flow into the central basin and has the potential to adversely affect aquifer recharge and resulting water table elevations.

Another effect on streams from the increased gradient might be to heighten the erosive power of the streams, potentially leading to headward erosion to the north and south. An extreme result of headwater erosion would be stream piracy, whereby an eastwardly flowing stream is intercepted (captured) and its waters diverted to the south by a headward-cutting stream.

A further potential damaging effect would be accelerated surface erosion of the terrain. Streams and surface runoff from the steep uplands immediately west of the basin currently debauch onto the low marsh in the central portion of the basin. Proposed harbor expansion would cause streams and runoff to enter the sea (the new harbor) almost 1/2 mile farther inland and at a steeper gradient than at present. Conceivable problems are accelerated erosion of the steep uplands to the west of the proposed harbor and possible realignment of streams.

Excavation of marsh and other sediments for harbor expansion in the central portion of the basin will decrease overburden pressures and possibly remove fine-grained, low permeability materials above the volcanic rock underlying the basin. Deep groundwater flowing in fractures and other discontinuities within the rock will have easier access to the surface underlying the proposed harbor area. Groundwater in the rock is presumably under artesian conditions imposed by elevated piezometric levels within the highlands to the west. Groundwater may tend to flow readily to the surface beneath the harbor and potentially create freshwater ponding beneath the harbor. What effect this upsurge of fresh water would have on the encroachment of the saltwater interface is unknown.

Harbor expansion would be expected to have little effect on discharge, sediment supply, and salinity of North Creek because it flows eastward to the sea north of the drainage divide. Stream piracy would, of course, divert the flow of North Creek, but piracy is an extreme result that is not expected. South Creek is not expected to be impacted for similar reasons. Stream discharge and sediment supply are not envisioned to change providing harbor construction avoids these creeks.

# 6 Conclusions and Recommendations

## Conclusions

The following conclusions are drawn from the work performed during this investigation:

*a.* The surface geology at the proposed harbor site consists of Holocene-age sediments deposited under specific depositional processes and associated environments. Most of the proposed harbor site is located in a marsh environment, formed by ponding of surface drainage from a Holocene abandoned beach ridge adjacent to the shoreline.

*b.* North and South Creeks are undergoing active stream downcutting, probably caused by regional and local tectonic and glacial-isostatic uplift of the earth's crust.

*c.* Available boring and offshore seismic data indicate the unconsolidated sedimentary fill at the head of Akutan Bay is generally coarse-grained. Available data indicate the fill is in excess of 45.7 m (150 ft) thick beneath the present shoreline. The depth to bedrock at the valley center at the shoreline is unknown. Because of its glacial origin, the depth to rock beneath the head of Akutan Bay may extend to more than 152.4 m (500 ft) deep, based on the projected slope of the uplands that border the harbor site.

*d.* Monitoring wells installed for this study indicate a shallow, unconfined aquifer system beneath the proposed harbor area. The water table is generally less than 0.6 m (2 ft) below ground surface in the Holocene valley fill. Based on the available boring and geologic data, the shallow aquifer probably extends to bedrock.

*e.* Salinity measurements made on water samples obtained from monitoring wells drilled during this study indicate the water table beneath the marsh is composed of fresh water.

*f.* Based on the Ghyben-Herzberg principle and water level measurements of monitoring wells and stream gages installed during this study, the salt-water wedge presently beneath the harbor site extends from the bay shoreline at 0 ft msl to about 365.8 m (-1,200 ft) msl along the western valley margin of the proposed maximum harbor outline. Currently, the saltwater interface extends inland into the fractured bedrock beneath the valley fill.

*g.* Existing groundwater models were reviewed to determine the model most suited to predict the impacts of harbor construction. A 1-D groundwater model based on the Ghyben-Herzberg Principle was best able to qualitatively predict the impacts to the water table and the saltwater interface due to harbor construction.

*h.* Harbor construction will potentially impact both surface water and groundwater flow into the central basin. Surface drainage and groundwater flow will no longer discharge to the east as they do now, but rather directly to the excavated basin from areas immediately adjacent to the harbor shoreline. Surface drainage and groundwater flow will discharge directly into the excavated harbor from the west (adjacent to uplands), south (South Creek area), and north (North Creek area).

*i.* Harbor expansion will potentially affect the water table in several ways. The shape of the water table will be altered, especially shortly after construction. Extending the shoreline inland will impose a new base level in the interior of the basin. A new base level will shorten the flow path and steepen the gradient, thus affecting the overall shape of the water table. It is assumed that the water levels will equivalently adjust themselves and eventually establish a new gradient similar to the current gradient. However, the new gradient will depend on the magnitude of recharge to the shallow aquifer in the headwaters of the valley.

*j.* The saltwater interface after harbor construction will move inland to the new shoreline and the new depth to the saltwater interface will be dependent upon the new elevation of the water table after construction. Exactly what the elevation of the water table will be following construction is unknown because of the limited amount of data on aquifer recharge. It is expected that the water table will have a similar gradient and elevation comparable to existing conditions, providing the volume of aquifer recharge is equivalent to the amount of groundwater discharging into the bay and to nearby streams after construction

*k.* Groundwater recharge to the shallow aquifer occurs by precipitation, surface drainage into the valley, and by fracture flow along the valley walls in contact with the unconsolidated Holocene fill. Previous studies at the head of Akutan Bay indicate that groundwater flow into North Creek represents a significant (i.e., approximately 25 percent) component of the stream discharge.

*l.* A potentially damaging effect of increased stream and groundwater gradients is accelerated surface erosion of the terrain. Increased stream gradients may heighten erosive power of the streams, potentially leading to headward erosion to the north and the south. An extreme situation would be stream piracy, whereby an eastward-flowing stream is intercepted, causing the headward-cutting stream to divert surface waters into the harbor basin.

*m.* Harbor expansion would be expected to have little effect on stream discharge, sediment supply, and salinity of North Creek because it flows eastward to the sea north of the drainage divide. South Creek is not expected to be impacted for similar reasons. Stream discharge and sediment supply along these creeks are not envisioned to change providing harbor construction directly avoids these creeks.

## Recommendations

The following recommendations are made for collection of additional data.

*a.* Establish a precipitation gage on Akutan Island for long-term data collection to support needed environmental requirements.

*b.* Obtain water level measurements from existing monitoring wells and gages throughout the course of the year. Only 1 week of groundwater data are presently available.

*c.* Install stream recorders on both South and North Creeks to obtain long-term stream discharge measurements.

*d.* Develop a drainage basin model for determining groundwater recharge and streamflow discharge.

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# Appendix A
# Soil Boring Logs

Boring Number: AKI-1

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446283 E, 5998302 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 7.877 ft msl; 2.401 m msl **Date:** 19 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 2.3 | Organics: vegetation and roots |
| 2.3 - 3.0 | Silty sand (SM): fine to medium grained, grains round to subangular, mixed volcanics, dark grey, organics, moist |
| 3.0 - 5.0 | Silty sand w. pea gravel (Sp): fine to coarse grained, 2 - 5 percent fine gravel (1/4 - 3/4 in.), grains round to subangular, mixed volcanics, dark grey, standing water at 2.5 ft. Soil sample 3 - 5 ft. |
| 5.0 - | Silty sand w. pea gravel (Sp): same, hole caving in below 5 ft. Assembled well and drove point to 6.45 ft depth. |

Well parameters: total length = 8.45 ft, tip = 0.7 ft, screen interval = 2.45 ft, pipe = 5.3 ft (2.0 ft stickup, 3.3 ft below ground), Bentonite 0.0 - 1.8 ft, sand 1.8 - 6.45 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-2

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446142 E, 5998300 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 10.469 ft msl; 3.191 m msl **Date:** 19 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 3.5 | Organics: vegetation and roots and mud; water at 1.0 ft. Salinity measurement: 83 ppm - Oakton TDSTestr |
| 3.5 - 4.3 | Silty sand (SM): fine to medium grained, grains round to subangular, mixed volcanics, dark grey, organics |
| 4.3 - 6.0 | Silty sand w. pea gravel (SP): fine to coarse grained, 2 - 5 percent fine gravel (1/4 - 3/4 in.), grains round to subangular, mixed volcanics, dark grey. Soil sample 4.3 - 6.0 ft. |
| | Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.5 ft depth |

Well parameters: total length = 8.5 ft, tip = 0.75 ft, screen interval = 2.5 ft, pipe = 5.25 ft (2.0 ft stickup, 3.25 ft below ground), Bentonite 0.4 - 1.8 ft, sand 1.8 - 6.5 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-3

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446102 E, 5998402 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 11.552 ft msl; 3.521 m msl **Date:** 20 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 3.5 | Organics: vegetation, roots, and mud; water at 0.95 ft. Salinity measurement: 85 ppm - Oakton TDSTestr |
| 3.5 - 4.0 | Silty sand (SM): fine to medium grained, grains round to subangular, mixed volcanics, dark grey, organics |
| 4.0 - 6.0 | Silty sand w. pea gravel (SP): fine to coarse grained, 2 - 5 percent fine gravel (1/4 - 3/4 in.), grains round to subangular, mixed volcanics, dark grey. Soil sample 4 - 5 ft. |
| | Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.55 ft depth |

Well parameters: total length = 8.55 ft, tip = 0.73 ft, screen interval = 2.42 ft, pipe = 5.4 ft (2.0 ft stickup, 3.4 ft below ground), Bentonite 0.0 - 2.0 ft, sand 2.0 - 6.0 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-4

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446065 E, 5998523 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 12.759 ft msl; 3.889 m msl **Date:** 20 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 2.75 | Organics: vegetation, roots, and mud; water at 1.0 ft. |
| 2.75 - 3.5 | Clayey gravel - sandy gravel (GC): fine to medium grained, grains round to subangular, mixed volcanics, dark grey, organics |
| 4.5 - 5.0 | Gravelly sands (SP): fine to coarse grained, 20 percent fine gravel (1/4 - 3/4 in.), grains round to subangular, mixed volcanics, dark grey. Soil sample 4.5 - 5 ft. |
| | Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.55 ft depth |

Well parameters: total length = 8.55 ft, tip = 0.73 ft, screen interval = 2.42 ft, pipe = 5.4 ft (2.0 ft stickup, 3.4 ft below ground), Bentonite 0.0 - 1.9 ft, sand 1.9 - 6.55 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-5

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 445860 E, 5998662 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 20.584 ft msl; 6.274 m msl **Date:** 21 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 1.5 | Organics: vegetation, roots, and mud; water at 1.0 ft. |
| 1.5 - 5.5 | Sand and fine gravel (SP): coarse sand, fine gravel, grains round to subangular, mixed volcanics, dark grey, organics to ~3 ft, moist to 2.5 ft; water at 2.5. Sample 3 - 5 ft. |
| | Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.3 ft depth |

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Well parameters: total length = 8.3 ft, tip = 0.7 ft, screen interval = 2.5 ft, pipe = 4.8 ft (2.0 ft stickup, 2.8 ft below ground), Bentonite 0.0 - 1.0 ft, sand 1.0 - 6.3 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-6

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 445943 E, 5998305 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 13.346 ft msl; 4.068 m msl **Date:** 21 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 6.0 | Organics, mud, ooze; water at 1.0 ft, no sand or gravel encountered. Possible lake or channel fill.<br><br>Assembled well and drove point to 5.85 ft depth |

Well parameters: total length = 7.85 ft, tip = 0.7 ft, screen interval = 2.4 ft, pipe = 4.75 ft (2.0 ft stickup, 2.75 ft below ground), Bentonite 0.0 - 1.0 ft, sand 1.0 - 5.85 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-7

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 445999 E, 5998155 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 14.308 ft msl; 4.361 m msl **Date:** 22 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 0.8 | Organics: vegetation and organic clay |
| 0.8 - 1.5 | Sandy clay (SC): soft, moist, dark grey - black |
| 1.5 - 3.5 | Silty sand (SM) with ash layers: sand is dark grey to green grey, fine - coarse grained, ash layers are v. fine, lt and dark grey, silt (ML), water at 1.8 ft. Salinity measurement: 30 - 40 ppm - Oakton TDSTestr |
| 3.5 - 6.0 | Coarse sand and fine gravel (SP): grains round to subangular, mixed volcanics, dark grey, wet. Sample 3.5 5.0 ft |

Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.55 ft depth

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Well parameters: total length = 8.55 ft, tip = 0.73 ft, screen interval = 2.42 ft, pipe = 5.35 ft (2.0 ft stickup, 3.15 ft below ground), Bentonite 0.0 - 1.0 ft, sand 1.0 - 6.55 ft. See Appendix B for screen elevations and ground-water level measurements.

Boring Number: AKI-8

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446232 E, 5998059 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 9.498 ft msl; 2.895 m msl **Date:** 22 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 0.8 | Organics: vegetation and roots |
| 0.8 - 1.2 | Organic clay (CL): dark grey - black, soft, w vegetation and roots |
| 1.2 - 1.5 | Volcanic ash (ML): dark black, silt/clay texture. Sample |
| 1.5 - 3.9 | Clay (CL and SC) and organic layers: organic layers are dark brown, moist, interbedded with dark grey clay layers |
| 3.9 - 4.5 | Grey clay (SC): dark grey, soft; wet at 3.8 ft. Sample |
| 4.5 - 5.0 | Orange coarse sand and gravel (SP): grains round to subangular, mixed volcanics, orange and dark grey, wet. Sample |
| 5.0 - | Hole caving in from 5 - 6 ft. Assembled well and drove point to 6.00-ft depth |

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Well parameters: total length = 8.00 ft, tip = 0.75 ft, screen interval = 2.4 ft, pipe = 4.9 ft (2.0 ft stickup, 2.9 ft below ground), Bentonite 0.0 - 1.0 ft, sand 1.0 - 6.55 ft. See Appendix B for screen elevations and groundwater level measurements.

Boring Number: AKI-9

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446363 E, 5998546 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 4.731 ft msl; 1.442 m msl **Date:** 22 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 1.0 | Organics: vegetation and roots |
| 1.0 - 3.5 | Contaminated soil - clay and silty sand; highly contaminated with petroleum, strong order and appearance, attempted to avoid direct contact with soil. |
| 3.5 - 5.5 | Sand and gravel (SP): coarse sand and fine gravel, black, dark grey. Contaminated |
| | Assembled well and drove point to 6.54-ft depth |
| | Note: approximately 20 barrels on top of old beach ridge, possible source of petroleum contamination. Barrels are present in the 1983 photograph of Akutan Bay area. |

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Well parameters: total length = 8.54 ft, tip = 0.7 ft, screen interval = 2.45 ft, pipe = 5.39 ft (2.54 ft stickup, 2.85 ft below ground), Bentonite 0.0 - 1.0 ft, sand 1.0 - 6.55 ft. See Appendix B for screen elevations and ground-water level measurements

Boring Number: AKI-OH-1

**Project:** Proposed Akutan Harbor **Site:** Head of Akutan Bay, Akutan Is., AK

**Location:** 446199 E, 5998537 N; UTM Zone 3; NAD 1983

**Surface Elevation:** 9.429 ft msl; 2.874 m msl **Date:** 21 Aug 2000

**Type of Sampler:** 3-1/4 in. (8.255 cm) Bucket Auger **Inspector:** J. B. Dunbar

| Interval (ft) | Description |
|---|---|
| 0.0 - 0.8 | Organics: vegetation and roots |
| 0.8 - 2.5 | Sand and gravel: coarse sand and fine gravel, grains round to subangular, mixed volcanics, orange and dark grey, water at ~1.8 ft, gravel is coarser with depth. Couldn't auger beyond 2.5 ft – location is on low Holocene terrace, former stream course containing alluvial gravels Abandoned hole. Boring will stay open, will monitor water level in open hole. See Appendix B for water level measurements. |

| Major Divisions | | Letter | Symbol: Hatching | Symbol: Color | Name | Value for Embankments | Permeability Cm Per Sec |
|---|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GW | | Red | Well-graded gravels or gravel-sand mixtures, little or no fines | Very stable, pervious shells of dikes and dams | $k > 10^{-2}$ |
| | | GP | | | Poorly-graded gravels or gravel-sand mixtures, little or no fines | Reasonably stable, pervious shells of dikes and dams | $k > 10^{-2}$ |
| | | GM | | Yellow | Silty gravels, gravel-sand-silt mixtures | Reasonably stable, not particularly suited to shells, but may be used for impervious cores or blankets | $k = 10^{-3}$ to $10^{-6}$ |
| | | GC | | | Clayey gravels, gravel-sand-clay mixtures | Fairly stable, may be used for impervious core | $k = 10^{-6}$ to $10^{-8}$ |
| | SAND AND SANDY SOILS | SW | | Red | Well-graded sands or gravelly sands, little or no fines | Very stable, pervious sections, slope protection required | $k > 10^{-3}$ |
| | | SP | | | Poorly-graded sands or gravelly sands, little or no fines | Reasonably stable, may be used in dike section with flat slopes | $k > 10^{-3}$ |
| | | SM | | Yellow | Silty sands, sand-silt mixtures | Fairly stable, not particularly suited to shells, but may be used for impervious cores or dikes | $k = 10^{-3}$ to $10^{-6}$ |
| | | SC | | | Clayey sands, sand-silt mixtures | Fairly stable, use for impervious core for flood control structures | $k = 10^{-6}$ to $10^{-8}$ |
| FINE GRAINED SOILS | SILTS AND CLAYS LL < 50 | ML | | Green | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity | Poor stability, may be used for embankments with proper control | $k = 10^{-3}$ to $10^{-6}$ |
| | | CL | | | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | Stable, impervious cores and blankets | $k = 10^{-6}$ to $10^{-8}$ |
| | | OL | | | Organic silts and organic silt-clays of low plasticity | Not suitable for embankments | $k = 10^{-4}$ to $10^{-6}$ |
| | SILTS AND CLAYS LL > 50 | MH | | Blue | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | Poor stability, core of hydraulic fill dam, not desirable in rolled fill construction | $k = 10^{-4}$ to $10^{-6}$ |
| | | CH | | | Inorganic clays of high plasticity, fat clays | Fair stability with flat slopes, thin cores, blankets and dike sections | $k = 10^{-6}$ to $10^{-8}$ |
| | | OH | | | Organic clays of medium to high plasticity, organic silts | Not suitable for embankments | $k = 10^{-6}$ to $10^{-8}$ |
| HIGHLY ORGANIC SOILS | | Pt | | Orange | Peat and other highly organic soils | Not used for construction | |

Figure A1. Unified Soil Classification System (U.S. Army Corps of Engineers 1995)

# Appendix B
# Monitoring Well and Stream Gage Measurements

**Well Number: AKI-1**

| Well Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Pipe Elv. | 9.964 | 3.037 |
| Ground Elv. | 7.877 | 2.401 |
| Top of Screen Elv. | 4.664 | 1.422 |
| Bottom Screen Elv | 2.214 | 0.675 |
| Bottom Elv. | 1.514 | 0.461 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | 1110 | 3.940 | 6.024 | 1.836 | |
| 20 Aug | 956 | 3.950 | 6.014 | 1.833 | |
| 21 Aug | 1740 | 4.000 | 5.964 | 1.818 | |
| 22 Aug | 1045 | 4.230 | 5.734 | 1.748 | |
| 23 Aug | 1058 | 4.800 | 5.164 | 1.574 | |

**Well Number: AKI-2**

| Well Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Pipe Elv. | 12.188 | 3.715 |
| Ground Elv. | 10.469 | 3.191 |
| Top of Screen Elv. | 6.938 | 2.115 |
| Bottom Screen Elv | 4.438 | 1.353 |
| Bottom Elv. | 3.688 | 1.124 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | 1153 | 2.750 | 9.438 | 2.877 | |
| 20 Aug | 1007 | 2.760 | 9.428 | 2.874 | |
| 21 Aug | 1752 | 2.780 | 9.408 | 2.868 | |
| 22 Aug | 1050 | 2.870 | 9.318 | 2.840 | |
| 22 Aug | 1748 | 2.820 | 9.368 | 2.855 | |
| 23 Aug | 1055 | 2.850 | 9.338 | 2.846 | |

**Well Number: AKI-3**

| Well Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Pipe Elv. | 13.681 | 4.170 |
| Ground Elv. | 11.552 | 3.521 |
| Top of Screen Elv. | 8.281 | 2.524 |
| Bottom Screen Elv | 5.861 | 1.786 |
| Bottom Elv. | 5.131 | 1.564 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl)) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | 738 | 2.700 | 10.981 | 3.347 | |
| 20 Aug | 1015 | 2.400 | 11.281 | 3.438 | |
| 21 Aug | 1845 | 2.700 | 10.981 | 3.347 | |
| 22 Aug | 1400 | 2.400 | 11.281 | 3.438 | |
| 23 Aug | 1050 | 2.760 | 10.921 | 3.329 | |

**Well Number: AKI-4**

| Well Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Pipe Elv. | 15.020 | 4.578 |
| Ground Elv. | 12.759 | 3.889 |
| Top of Screen Elv. | 9.620 | 2.932 |
| Bottom Screen Elv | 7.220 | 2.201 |
| Bottom Elv. | 6.470 | 1.972 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | 845 | 2.780 | 12.240 | 3.731 | |
| 20 Aug | 1038 | 3.110 | 11.910 | 3.630 | |
| 21 Aug | 1838 | 5.460 | 9.560 | 2.914 | |
| 22 Aug | 1430 | 2.780 | 12.240 | 3.731 | |
| 23 Aug | 1037 | 3.100 | 11.920 | 3.633 | |

**Well Number: AKI-5**

| Well Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Pipe Elv. | 22.756 | 6.936 |
| Ground Elv. | 20.584 | 6.274 |
| Top of Screen Elv. | 17.956 | 5.473 |
| Bottom Screen Elv | 15.456 | 4.711 |
| Bottom Elv. | 14.756 | 4.498 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 21 Aug | 1810 | 6.610 | 16.146 | 4.921 | |
| 22 Aug | 1145 | 4.980 | 17.776 | 5.418 | |
| 23 Aug | 952 | 5.000 | 17.756 | 5.412 | |

**Well Number: AKI-6**

| Well Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Pipe Elv. | 15.482 | 4.719 |
| Ground Elv. | 13.346 | 4.068 |
| Top of Screen Elv. | 10.732 | 3.271 |
| Bottom Screen Elv | 8.332 | 2.540 |
| Bottom Elv. | 7.632 | 2.326 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 21 Aug | 1758 | 2.320 | 13.162 | 4.012 | |
| 22 Aug | 1115 | 2.350 | 13.132 | 4.003 | |
| 23 Aug | 937 | 2.280 | 13.202 | 4.024 | |

**Well Number: AKI-7**

| Well Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Pipe Elv. | 16.440 | 5.011 |
| Ground Elv. | 14.308 | 4.361 |
| Top of Screen Elv. | 11.040 | 3.365 |
| Bottom Screen Elv | 8.620 | 2.627 |
| Bottom Elv. | 7.890 | 2.405 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 21 Aug | 1850 | 3.850 | 12.590 | 3.838 | |
| 22 Aug | 1635 | 3.880 | 12.560 | 3.828 | |
| 23 Aug | 930 | 3.900 | 12.540 | 3.822 | |

**Well Number: AKI-8**

| Well Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Pipe Elv. | 11.667 | 3.556 |
| Ground Elv. | 9.498 | 2.895 |
| Top of Screen Elv. | 7.067 | 2.154 |
| Bottom Screen Elv | 4.417 | 1.346 |
| Bottom Elv. | 3.667 | 1.118 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 21 Aug | 1859 | 5.020 | 6.647 | 2.026 | |
| 22 Aug | 1625 | 5.100 | 6.567 | 2.002 | |
| 23 Aug | 925 | 5.100 | 6.567 | 2.002 | |

**Well Number: AKI-9**

| Well Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Pipe Elv. | 7.510 | 2.289 |
| Ground Elv. | 4.731 | 1.442 |
| Top of Screen Elv. | 2.120 | 0.646 |
| Bottom Screen Elv | -0.330 | -0.101 |
| Bottom Elv. | -1.030 | -0.314 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 22 Aug | 1607 | 4.780 | 2.730 | 0.832 | |
| 23 Aug | 1128 | 4.850 | 2.660 | 0.811 | |

**Monitoring Point: AKI-OH-1**

| Parameters | Elevation ft-msl | Elevation m-msl |
|---|---|---|
| Top of Stake Elv. | 12.359 | 3.767 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | | 4.400 | 7.959 | 1.341 | |
| 20 Aug | 1120 | 4.200 | 8.159 | 1.280 | |
| 21 Aug | 1836 | 4.400 | 7.959 | 1.341 | |
| 22 Aug | 1437 | 4.400 | 7.959 | 1.341 | |
| 23 Aug | | 4.380 | 7.979 | 1.335 | |

**Monitoring Point: NG2**

| Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Stake Elv. | 7.428 | 2.264 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 19 Aug | | 2.100 | 5.328 | 1.624 | |
| 20 Aug | | 2.100 | 5.328 | 1.624 | |
| 20Aug | | 5.328 | 1.624 | Survey Elv. | |
| 21 Aug | | 2.150 | 5.278 | 1.609 | |
| 22 Aug | | 2.210 | 5.218 | 1.590 | |
| 23 Aug | | 2.250 | 5.178 | 1.578 | |

**Monitoring Point: NG3**

| Parameters | Elevation ft-msl | m-msl |
|---|---|---|
| Top of Stake Elv. | 13.878 | 4.230 |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 20 Aug | | | 11.250 | 3.429 | Survey Elv. |
| 21 Aug | | 2.640 | 11.238 | 3.425 | |
| 22 Aug | | 2.700 | 11.178 | 3.407 | |

**Monitoring Point: NG4**

| Parameters | Elevation ft-msl | Elevation m-msl | |
|---|---|---|---|
| Bottom of Stream Elv. | 15.292 | 4.661 | Bottom measurement, stick bent |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 20 Aug | | | 16.060 | 4.895 | Survey Elv. |
| 21 Aug | | 0.620 | 15.912 | 4.850 | |
| 22 Aug | | 0.600 | 15.892 | 4.844 | |
| 23 Aug | | 0.580 | 15.872 | 4.838 | |

**Monitoring Point: NG6**

| Parameters | Elevation ft-msl | Elevation m-msl | |
|---|---|---|---|
| Bottom of Stream Elv. | 22.835 | 6.960 | Bottom measurement, stick bent |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 20 Aug | | | 23.589 | 7.190 | Survey Elv. |
| 22 Aug | | 0.850 | 23.685 | 7.219 | |
| 23 Aug | | 0.850 | 23.685 | 7.219 | |

**Monitoring Point: NG7**

| | Elevation | | |
|---|---|---|---|
| Parameters | ft-msl | m-msl | |
| Bottom of Stream Elv. | 25.223 | 7.688 | Bottom measurement, stick bent |

Water Level Measurements

| Date | Time (Hrs) | Depth (ft) | Elevation (ft-msl) | Elevation (m-msl) | Remarks |
|---|---|---|---|---|---|
| 20 Aug | | | 26.365 | 8.036 | Survey Elv. |
| 22 Aug | 1215 | 1.100 | 26.323 | 8.023 | |

# Appendix C
# Automated Tide Gage Data

Akutan Bay Tide Gage Data

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/11/00 | 12:00 AM | 2460 | 21.61 | -0.145 | -1.97 |
| 08/11/00 | 12:15 AM | 2475 | 21.62 | -0.145 | -1.97 |
| 08/11/00 | 12:30 AM | 2490 | 21.63 | -0.146 | -1.96 |
| 08/11/00 | 12:45 AM | 2505 | 21.63 | -0.145 | -1.97 |
| 08/11/00 | 01:00 AM | 2520 | 21.63 | -0.145 | -1.97 |
| 08/11/00 | 01:15 AM | 2535 | 21.64 | -0.146 | -1.96 |
| 08/11/00 | 01:30 AM | 2550 | 21.64 | -0.146 | -1.96 |
| 08/11/00 | 01:45 AM | 2565 | 21.65 | -0.145 | -1.97 |
| 08/11/00 | 02:00 AM | 2580 | 21.65 | -0.146 | -1.96 |
| 08/11/00 | 02:15 AM | 2595 | 21.67 | -0.148 | -1.96 |
| 08/11/00 | 02:30 AM | 2610 | 21.68 | -0.149 | -1.95 |
| 08/11/00 | 02:45 AM | 2625 | 21.68 | -0.149 | -1.95 |
| 08/11/00 | 03:00 AM | 2640 | 21.69 | -0.149 | -1.95 |
| 08/11/00 | 03:15 AM | 2655 | 21.71 | -0.15 | -1.95 |
| 08/11/00 | 03:30 AM | 2670 | 21.73 | -0.15 | -1.95 |
| 08/11/00 | 03:45 AM | 2685 | 21.74 | -0.15 | -1.95 |
| 08/11/00 | 04:00 AM | 2700 | 21.76 | -0.15 | -1.95 |
| 08/11/00 | 04:15 AM | 2715 | 21.78 | -0.149 | -1.95 |
| 08/11/00 | 04:30 AM | 2730 | 21.8 | -0.148 | -1.96 |
| 08/11/00 | 04:45 AM | 2745 | 21.83 | -0.147 | -1.96 |
| 08/11/00 | 05:00 AM | 2760 | 21.85 | -0.147 | -1.96 |
| 08/11/00 | 05:15 AM | 2775 | 21.87 | -0.148 | -1.96 |
| 08/11/00 | 05:30 AM | 2790 | 21.9 | -0.148 | -1.96 |
| 08/11/00 | 05:45 AM | 2805 | 21.91 | -0.148 | -1.96 |
| 08/11/00 | 06:00 AM | 2820 | 21.95 | -0.147 | -1.96 |
| 08/11/00 | 06:15 AM | 2835 | 21.98 | -0.148 | -1.96 |
| 08/11/00 | 06:30 AM | 2850 | 22 | -0.148 | -1.96 |
| 08/11/00 | 06:45 AM | 2865 | 22.02 | -0.15 | -1.95 |
| 08/11/00 | 07:00 AM | 2880 | 22.05 | -0.15 | -1.95 |
| 08/11/00 | 07:15 AM | 2895 | 22.07 | -0.148 | -1.96 |
| 08/11/00 | 07:30 AM | 2910 | 22.11 | -0.149 | -1.95 |
| 08/11/00 | 07:45 AM | 2925 | 22.14 | -0.149 | -1.95 |
| 08/11/00 | 08:00 AM | 2940 | 22.16 | -0.15 | -1.95 |
| 08/11/00 | 08:15 AM | 2955 | 22 | -0.151 | -1.95 |
| 08/11/00 | 08:30 AM | 2970 | 20.62 | -0.15 | -1.95 |
| 08/11/00 | 08:45 AM | 2985 | 18.16 | -0.162 | -1.91 |
| 08/11/00 | 09:00 AM | 3000 | 15.37 | -0.162 | -1.91 |
| 08/11/00 | 09:15 AM | 3015 | 14.48 | -0.163 | -1.91 |
| 08/11/00 | 09:30 AM | 3030 | 14.11 | -0.164 | -1.90 |
| 08/11/00 | 09:45 AM | 3045 | 13.83 | -0.163 | -1.91 |
| 08/11/00 | 10:00 AM | 3060 | 13.45 | -0.163 | -1.91 |
| 08/11/00 | 10:15 AM | 3075 | 13.42 | -0.16 | -1.92 |
| 08/11/00 | 10:30 AM | 3090 | 14.81 | -0.162 | -1.91 |
| 08/11/00 | 10:45 AM | 3105 | 15.59 | -0.162 | -1.91 |
| 08/11/00 | 11:00 AM | 3120 | 16.51 | -0.162 | -1.91 |
| 08/11/00 | 11:15 AM | 3135 | 15.69 | -0.165 | -1.90 |
| 08/11/00 | 11:30 AM | 3150 | 14.82 | -0.168 | -1.89 |
| 08/11/00 | 11:45 AM | 3165 | 14.82 | -0.168 | -1.89 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/11/00 | 12:00 PM | 3180 | 15.09 | -0.169 | -1.89 |
| 08/11/00 | 12:15 PM | 3195 | 15.6 | -0.169 | -1.89 |
| 08/11/00 | 12:30 PM | 3210 | 15.68 | -0.168 | -1.89 |
| 08/11/00 | 12:45 PM | 3225 | 16.84 | -0.167 | -1.89 |
| 08/11/00 | 01:00 PM | 3240 | 12.95 | -0.778 | 0.11 |
| 08/11/00 | 01:15 PM | 3255 | 12.5 | -0.816 | 0.24 |
| 08/11/00 | 01:30 PM | 3270 | 12.49 | -0.901 | 0.52 |
| 08/11/00 | 01:45 PM | 3285 | 12.58 | -0.936 | 0.63 |
| 08/11/00 | 02:00 PM | 3300 | 12.64 | -0.999 | 0.84 |
| 08/11/00 | 02:15 PM | 3315 | 12.63 | -1.045 | 0.99 |
| 08/11/00 | 02:30 PM | 3330 | 12.65 | -1.109 | 1.20 |
| 08/11/00 | 02:45 PM | 3345 | 12.68 | -1.175 | 1.41 |
| 08/11/00 | 03:00 PM | 3360 | 12.74 | -1.196 | 1.48 |
| 08/11/00 | 03:15 PM | 3375 | 11.54 | -1.237 | 1.62 |
| 08/11/00 | 03:30 PM | 3390 | 10.37 | -1.325 | 1.91 |
| 08/11/00 | 03:45 PM | 3405 | 9.97 | -1.362 | 2.03 |
| 08/11/00 | 04:00 PM | 3420 | 9.7 | -1.382 | 2.09 |
| 08/11/00 | 04:15 PM | 3435 | 9.37 | -1.436 | 2.27 |
| 08/11/00 | 04:30 PM | 3450 | 9.16 | -1.483 | 2.42 |
| 08/11/00 | 04:45 PM | 3465 | 9.04 | -1.525 | 2.56 |
| 08/11/00 | 05:00 PM | 3480 | 9.04 | -1.533 | 2.59 |
| 08/11/00 | 05:15 PM | 3495 | 8.93 | -1.595 | 2.79 |
| 08/11/00 | 05:30 PM | 3510 | 8.79 | -1.622 | 2.88 |
| 08/11/00 | 05:45 PM | 3525 | 8.73 | -1.629 | 2.90 |
| 08/11/00 | 06:00 PM | 3540 | 8.72 | -1.665 | 3.02 |
| 08/11/00 | 06:15 PM | 3555 | 8.77 | -1.686 | 3.09 |
| 08/11/00 | 06:30 PM | 3570 | 8.82 | -1.708 | 3.16 |
| 08/11/00 | 06:45 PM | 3585 | 10.3 | -1.683 | 3.08 |
| 08/11/00 | 07:00 PM | 3600 | 10.75 | -1.692 | 3.11 |
| 08/11/00 | 07:15 PM | 3615 | 10.43 | -1.715 | 3.19 |
| 08/11/00 | 07:30 PM | 3630 | 9.21 | -1.71 | 3.17 |
| 08/11/00 | 07:45 PM | 3645 | 8.91 | -1.679 | 3.07 |
| 08/11/00 | 08:00 PM | 3660 | 8.85 | -1.685 | 3.09 |
| 08/11/00 | 08:15 PM | 3675 | 8.85 | -1.706 | 3.16 |
| 08/11/00 | 08:30 PM | 3690 | 8.71 | -1.68 | 3.07 |
| 08/11/00 | 08:45 PM | 3705 | 8.69 | -1.67 | 3.04 |
| 08/11/00 | 09:00 PM | 3720 | 8.67 | -1.687 | 3.09 |
| 08/11/00 | 09:15 PM | 3735 | 8.69 | -1.682 | 3.08 |
| 08/11/00 | 09:30 PM | 3750 | 8.76 | -1.648 | 2.97 |
| 08/11/00 | 09:45 PM | 3765 | 8.8 | -1.634 | 2.92 |
| 08/11/00 | 10:00 PM | 3780 | 8.85 | -1.656 | 2.99 |
| 08/11/00 | 10:15 PM | 3795 | 8.83 | -1.672 | 3.04 |
| 08/11/00 | 10:30 PM | 3810 | 8.81 | -1.641 | 2.94 |
| 08/11/00 | 10:45 PM | 3825 | 9.1 | -1.636 | 2.93 |
| 08/11/00 | 11:00 PM | 3840 | 8.98 | -1.664 | 3.02 |
| 08/11/00 | 11:15 PM | 3855 | 10.96 | -1.654 | 2.99 |
| 08/11/00 | 11:30 PM | 3870 | 12.36 | -1.636 | 2.93 |
| 08/11/00 | 11:45 PM | 3885 | 12.99 | -1.652 | 2.98 |
| 08/12/00 | 12:00 AM | 3900 | 13.17 | -1.693 | 3.11 |
| 08/12/00 | 12:15 AM | 3915 | 13.14 | -1.676 | 3.06 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/12/00 | 12:30 AM | 3930 | 13.39 | -1.681 | 3.07 |
| 08/12/00 | 12:45 AM | 3945 | 13.52 | -1.689 | 3.10 |
| 08/12/00 | 01:00 AM | 3960 | 13.56 | -1.725 | 3.22 |
| 08/12/00 | 01:15 AM | 3975 | 13.88 | -1.743 | 3.28 |
| 08/12/00 | 01:30 AM | 3990 | 13.96 | -1.736 | 3.25 |
| 08/12/00 | 01:45 AM | 4005 | 13.94 | -1.747 | 3.29 |
| 08/12/00 | 02:00 AM | 4020 | 13.86 | -1.761 | 3.34 |
| 08/12/00 | 02:15 AM | 4035 | 13.74 | -1.785 | 3.42 |
| 08/12/00 | 02:30 AM | 4050 | 13.62 | -1.744 | 3.28 |
| 08/12/00 | 02:45 AM | 4065 | 13.53 | -1.758 | 3.33 |
| 08/12/00 | 03:00 AM | 4080 | 13.46 | -1.76 | 3.33 |
| 08/12/00 | 03:15 AM | 4095 | 13.41 | -1.734 | 3.25 |
| 08/12/00 | 03:30 AM | 4110 | 13.39 | -1.718 | 3.20 |
| 08/12/00 | 03:45 AM | 4125 | 13.1 | -1.706 | 3.16 |
| 08/12/00 | 04:00 AM | 4140 | 12.94 | -1.709 | 3.17 |
| 08/12/00 | 04:15 AM | 4155 | 12.93 | -1.687 | 3.09 |
| 08/12/00 | 04:30 AM | 4170 | 12.86 | -1.675 | 3.05 |
| 08/12/00 | 04:45 AM | 4185 | 12.68 | -1.634 | 2.92 |
| 08/12/00 | 05:00 AM | 4200 | 12.78 | -1.641 | 2.94 |
| 08/12/00 | 05:15 AM | 4215 | 12.71 | -1.594 | 2.79 |
| 08/12/00 | 05:30 AM | 4230 | 12.72 | -1.538 | 2.60 |
| 08/12/00 | 05:45 AM | 4245 | 12.86 | -1.509 | 2.51 |
| 08/12/00 | 06:00 AM | 4260 | 12.99 | -1.467 | 2.37 |
| 08/12/00 | 06:15 AM | 4275 | 13.14 | -1.427 | 2.24 |
| 08/12/00 | 06:30 AM | 4290 | 13.16 | -1.362 | 2.03 |
| 08/12/00 | 06:45 AM | 4305 | 13.1 | -1.327 | 1.91 |
| 08/12/00 | 07:00 AM | 4320 | 13.17 | -1.301 | 1.83 |
| 08/12/00 | 07:15 AM | 4335 | 13.21 | -1.24 | 1.63 |
| 08/12/00 | 07:30 AM | 4350 | 13.25 | -1.162 | 1.37 |
| 08/12/00 | 07:45 AM | 4365 | 13.3 | -1.134 | 1.28 |
| 08/12/00 | 08:00 AM | 4380 | 13.25 | -1.083 | 1.11 |
| 08/12/00 | 08:15 AM | 4395 | 13.27 | -1.037 | 0.96 |
| 08/12/00 | 08:30 AM | 4410 | 13.36 | -0.964 | 0.72 |
| 08/12/00 | 08:45 AM | 4425 | 13.43 | -0.908 | 0.54 |
| 08/12/00 | 09:00 AM | 4440 | 13.51 | -0.868 | 0.41 |
| 08/12/00 | 09:15 AM | 4455 | 13.54 | -0.827 | 0.27 |
| 08/12/00 | 09:30 AM | 4470 | 13.58 | -0.776 | 0.10 |
| 08/12/00 | 09:45 AM | 4485 | 13.59 | -0.728 | -0.05 |
| 08/12/00 | 10:00 AM | 4500 | 13.63 | -0.73 | -0.05 |
| 08/12/00 | 10:15 AM | 4515 | 13.67 | -0.666 | -0.26 |
| 08/12/00 | 10:30 AM | 4530 | 13.71 | -0.633 | -0.36 |
| 08/12/00 | 10:45 AM | 4545 | 13.76 | -0.631 | -0.37 |
| 08/12/00 | 11:00 AM | 4560 | 13.71 | -0.645 | -0.32 |
| 08/12/00 | 11:15 AM | 4575 | 13.61 | -0.626 | -0.39 |
| 08/12/00 | 11:30 AM | 4590 | 13.62 | -0.631 | -0.37 |
| 08/12/00 | 11:45 AM | 4605 | 13.69 | -0.607 | -0.45 |
| 08/12/00 | 12:00 PM | 4620 | 13.78 | -0.628 | -0.38 |
| 08/12/00 | 12:15 PM | 4635 | 13.81 | -0.621 | -0.40 |
| 08/12/00 | 12:30 PM | 4650 | 13.83 | -0.638 | -0.35 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/12/00 | 12:45 PM | 4665 | 13.96 | -0.703 | -0.13 |
| 08/12/00 | 01:00 PM | 4680 | 14.04 | -0.696 | -0.16 |
| 08/12/00 | 01:15 PM | 4695 | 14.05 | -0.735 | -0.03 |
| 08/12/00 | 01:30 PM | 4710 | 14.16 | -0.783 | 0.13 |
| 08/12/00 | 01:45 PM | 4725 | 14.35 | -0.844 | 0.33 |
| 08/12/00 | 02:00 PM | 4740 | 14.4 | -0.866 | 0.40 |
| 08/12/00 | 02:15 PM | 4755 | 14.35 | -0.906 | 0.53 |
| 08/12/00 | 02:30 PM | 4770 | 14.33 | -0.962 | 0.72 |
| 08/12/00 | 02:45 PM | 4785 | 14.51 | -1.034 | 0.95 |
| 08/12/00 | 03:00 PM | 4800 | 14.61 | -1.064 | 1.05 |
| 08/12/00 | 03:15 PM | 4815 | 14.47 | -1.121 | 1.24 |
| 08/12/00 | 03:30 PM | 4830 | 14.2 | -1.195 | 1.48 |
| 08/12/00 | 03:45 PM | 4845 | 14.26 | -1.24 | 1.63 |
| 08/12/00 | 04:00 PM | 4860 | 14.37 | -1.284 | 1.77 |
| 08/12/00 | 04:15 PM | 4875 | 14.39 | -1.306 | 1.84 |
| 08/12/00 | 04:30 PM | 4890 | 14.37 | -1.353 | 2.00 |
| 08/12/00 | 04:45 PM | 4905 | 14.1 | -1.409 | 2.18 |
| 08/12/00 | 05:00 PM | 4920 | 14.18 | -1.459 | 2.35 |
| 08/12/00 | 05:15 PM | 4935 | 14.19 | -1.492 | 2.45 |
| 08/12/00 | 05:30 PM | 4950 | 14.32 | -1.503 | 2.49 |
| 08/12/00 | 05:45 PM | 4965 | 14.42 | -1.566 | 2.70 |
| 08/12/00 | 06:00 PM | 4980 | 14.49 | -1.597 | 2.80 |
| 08/12/00 | 06:15 PM | 4995 | 14.53 | -1.625 | 2.89 |
| 08/12/00 | 06:30 PM | 5010 | 14.57 | -1.637 | 2.93 |
| 08/12/00 | 06:45 PM | 5025 | 14.61 | -1.673 | 3.05 |
| 08/12/00 | 07:00 PM | 5040 | 14.62 | -1.681 | 3.07 |
| 08/12/00 | 07:15 PM | 5055 | 14.6 | -1.697 | 3.13 |
| 08/12/00 | 07:30 PM | 5070 | 14.61 | -1.718 | 3.20 |
| 08/12/00 | 07:45 PM | 5085 | 14.65 | -1.717 | 3.19 |
| 08/12/00 | 08:00 PM | 5100 | 14.67 | -1.707 | 3.16 |
| 08/12/00 | 08:15 PM | 5115 | 14.72 | -1.714 | 3.18 |
| 08/12/00 | 08:30 PM | 5130 | 14.78 | -1.731 | 3.24 |
| 08/12/00 | 08:45 PM | 5145 | 14.75 | -1.723 | 3.21 |
| 08/12/00 | 09:00 PM | 5160 | 14.73 | -1.707 | 3.16 |
| 08/12/00 | 09:15 PM | 5175 | 14.73 | -1.717 | 3.19 |
| 08/12/00 | 09:30 PM | 5190 | 14.73 | -1.714 | 3.18 |
| 08/12/00 | 09:45 PM | 5205 | 14.89 | -1.697 | 3.13 |
| 08/12/00 | 10:00 PM | 5220 | 15.06 | -1.699 | 3.13 |
| 08/12/00 | 10:15 PM | 5235 | 15.05 | -1.692 | 3.11 |
| 08/12/00 | 10:30 PM | 5250 | 15.04 | -1.708 | 3.16 |
| 08/12/00 | 10:45 PM | 5265 | 14.99 | -1.702 | 3.14 |
| 08/12/00 | 11:00 PM | 5280 | 14.96 | -1.682 | 3.08 |
| 08/12/00 | 11:15 PM | 5295 | 13.86 | -1.694 | 3.12 |
| 08/12/00 | 11:30 PM | 5310 | 13.69 | -1.692 | 3.11 |
| 08/12/00 | 11:45 PM | 5325 | 13.6 | -1.687 | 3.09 |
| 08/13/00 | 12:00 AM | 5340 | 13.63 | -1.703 | 3.15 |
| 08/13/00 | 12:15 AM | 5355 | 13.63 | -1.692 | 3.11 |
| 08/13/00 | 12:30 AM | 5370 | 13.49 | -1.699 | 3.13 |
| 08/13/00 | 12:45 AM | 5385 | 13.25 | -1.722 | 3.21 |
| 08/13/00 | 01:00 AM | 5400 | 13.27 | -1.713 | 3.18 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/13/00 | 01:15 AM | 5415 | 13.16 | -1.717 | 3.19 |
| 08/13/00 | 01:30 AM | 5430 | 13.08 | -1.723 | 3.21 |
| 08/13/00 | 01:45 AM | 5445 | 12.92 | -1.746 | 3.29 |
| 08/13/00 | 02:00 AM | 5460 | 12.86 | -1.753 | 3.31 |
| 08/13/00 | 02:15 AM | 5475 | 12.82 | -1.751 | 3.30 |
| 08/13/00 | 02:30 AM | 5490 | 12.8 | -1.743 | 3.28 |
| 08/13/00 | 02:45 AM | 5505 | 12.83 | -1.743 | 3.28 |
| 08/13/00 | 03:00 AM | 5520 | 12.73 | -1.749 | 3.30 |
| 08/13/00 | 03:15 AM | 5535 | 12.64 | -1.754 | 3.31 |
| 08/13/00 | 03:30 AM | 5550 | 12.37 | -1.737 | 3.26 |
| 08/13/00 | 03:45 AM | 5565 | 12.28 | -1.73 | 3.23 |
| 08/13/00 | 04:00 AM | 5580 | 12.27 | -1.732 | 3.24 |
| 08/13/00 | 04:15 AM | 5595 | 12.43 | -1.699 | 3.13 |
| 08/13/00 | 04:30 AM | 5610 | 12.31 | -1.659 | 3.00 |
| 08/13/00 | 04:45 AM | 5625 | 12.19 | -1.676 | 3.06 |
| 08/13/00 | 05:00 AM | 5640 | 12.09 | -1.648 | 2.97 |
| 08/13/00 | 05:15 AM | 5655 | 12.07 | -1.621 | 2.88 |
| 08/13/00 | 05:30 AM | 5670 | 11.92 | -1.602 | 2.81 |
| 08/13/00 | 05:45 AM | 5685 | 11.67 | -1.552 | 2.65 |
| 08/13/00 | 06:00 AM | 5700 | 11.52 | -1.527 | 2.57 |
| 08/13/00 | 06:15 AM | 5715 | 11.45 | -1.502 | 2.49 |
| 08/13/00 | 06:30 AM | 5730 | 11.42 | -1.453 | 2.33 |
| 08/13/00 | 06:45 AM | 5745 | 11.32 | -1.419 | 2.21 |
| 08/13/00 | 07:00 AM | 5760 | 10.91 | -1.375 | 2.07 |
| 08/13/00 | 07:15 AM | 5775 | 10.59 | -1.325 | 1.91 |
| 08/13/00 | 07:30 AM | 5790 | 10.45 | -1.274 | 1.74 |
| 08/13/00 | 07:45 AM | 5805 | 10.33 | -1.234 | 1.61 |
| 08/13/00 | 08:00 AM | 5820 | 10.22 | -1.188 | 1.46 |
| 08/13/00 | 08:15 AM | 5835 | 10.19 | -1.135 | 1.28 |
| 08/13/00 | 08:30 AM | 5850 | 10.17 | -1.039 | 0.97 |
| 08/13/00 | 08:45 AM | 5865 | 10.24 | -1.015 | 0.89 |
| 08/13/00 | 09:00 AM | 5880 | 10.22 | -1.004 | 0.85 |
| 08/13/00 | 09:15 AM | 5895 | 10.22 | -0.953 | 0.69 |
| 08/13/00 | 09:30 AM | 5910 | 10.29 | -0.856 | 0.37 |
| 08/13/00 | 09:45 AM | 5925 | 10.32 | -0.81 | 0.22 |
| 08/13/00 | 10:00 AM | 5940 | 10.3 | -0.795 | 0.17 |
| 08/13/00 | 10:15 AM | 5955 | 10.32 | -0.766 | 0.07 |
| 08/13/00 | 10:30 AM | 5970 | 10.41 | -0.735 | -0.03 |
| 08/13/00 | 10:45 AM | 5985 | 10.52 | -0.716 | -0.09 |
| 08/13/00 | 11:00 AM | 6000 | 10.61 | -0.691 | -0.17 |
| 08/13/00 | 11:15 AM | 6015 | 10.7 | -0.709 | -0.11 |
| 08/13/00 | 11:30 AM | 6030 | 10.88 | -0.643 | -0.33 |
| 08/13/00 | 11:45 AM | 6045 | 10.97 | -0.666 | -0.26 |
| 08/13/00 | 12:00 PM | 6060 | 11.13 | -0.678 | -0.22 |
| 08/13/00 | 12:15 PM | 6075 | 11.52 | -0.666 | -0.26 |
| 08/13/00 | 12:30 PM | 6090 | 11.93 | -0.668 | -0.25 |
| 08/13/00 | 12:45 PM | 6105 | 12.39 | -0.63 | -0.37 |
| 08/13/00 | 01:00 PM | 6120 | 12.71 | -0.695 | -0.16 |
| 08/13/00 | 01:15 PM | 6135 | 13.13 | -0.709 | -0.11 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/13/00 | 01:30 PM | 6150 | 13.23 | -0.723 | -0.07 |
| 08/13/00 | 01:45 PM | 6165 | 13.11 | -0.758 | 0.05 |
| 08/13/00 | 02:00 PM | 6180 | 13 | -0.814 | 0.23 |
| 08/13/00 | 02:15 PM | 6195 | 12.9 | -0.824 | 0.26 |
| 08/13/00 | 02:30 PM | 6210 | 13 | -0.854 | 0.36 |
| 08/13/00 | 02:45 PM | 6225 | 12.92 | -0.913 | 0.55 |
| 08/13/00 | 03:00 PM | 6240 | 13 | -1.003 | 0.85 |
| 08/13/00 | 03:15 PM | 6255 | 13.11 | -1.011 | 0.88 |
| 08/13/00 | 03:30 PM | 6270 | 13.09 | -1.038 | 0.96 |
| 08/13/00 | 03:45 PM | 6285 | 12.89 | -1.088 | 1.13 |
| 08/13/00 | 04:00 PM | 6300 | 12.73 | -1.159 | 1.36 |
| 08/13/00 | 04:15 PM | 6315 | 12.5 | -1.185 | 1.45 |
| 08/13/00 | 04:30 PM | 6330 | 12.28 | -1.233 | 1.60 |
| 08/13/00 | 04:45 PM | 6345 | 12.49 | -1.276 | 1.75 |
| 08/13/00 | 05:00 PM | 6360 | 13.03 | -1.32 | 1.89 |
| 08/13/00 | 05:15 PM | 6375 | 13.27 | -1.358 | 2.01 |
| 08/13/00 | 05:30 PM | 6390 | 13.35 | -1.389 | 2.12 |
| 08/13/00 | 05:45 PM | 6405 | 13.34 | -1.462 | 2.36 |
| 08/13/00 | 06:00 PM | 6420 | 13.41 | -1.495 | 2.46 |
| 08/13/00 | 06:15 PM | 6435 | 13.45 | -1.526 | 2.57 |
| 08/13/00 | 06:30 PM | 6450 | 13.81 | -1.54 | 2.61 |
| 08/13/00 | 06:45 PM | 6465 | 13.98 | -1.583 | 2.75 |
| 08/13/00 | 07:00 PM | 6480 | 13.81 | -1.594 | 2.79 |
| 08/13/00 | 07:15 PM | 6495 | 13.73 | -1.625 | 2.89 |
| 08/13/00 | 07:30 PM | 6510 | 13.73 | -1.666 | 3.02 |
| 08/13/00 | 07:45 PM | 6525 | 13.7 | -1.649 | 2.97 |
| 08/13/00 | 08:00 PM | 6540 | 13.58 | -1.692 | 3.11 |
| 08/13/00 | 08:15 PM | 6555 | 13.49 | -1.675 | 3.05 |
| 08/13/00 | 08:30 PM | 6570 | 13.53 | -1.694 | 3.12 |
| 08/13/00 | 08:45 PM | 6585 | 13.52 | -1.699 | 3.13 |
| 08/13/00 | 09:00 PM | 6600 | 13.51 | -1.721 | 3.21 |
| 08/13/00 | 09:15 PM | 6615 | 13.48 | -1.699 | 3.13 |
| 08/13/00 | 09:30 PM | 6630 | 13.45 | -1.704 | 3.15 |
| 08/13/00 | 09:45 PM | 6645 | 13.43 | -1.715 | 3.19 |
| 08/13/00 | 10:00 PM | 6660 | 13.41 | -1.704 | 3.15 |
| 08/13/00 | 10:15 PM | 6675 | 13.41 | -1.692 | 3.11 |
| 08/13/00 | 10:30 PM | 6690 | 13.45 | -1.689 | 3.10 |
| 08/13/00 | 10:45 PM | 6705 | 13.47 | -1.713 | 3.18 |
| 08/13/00 | 11:00 PM | 6720 | 13.47 | -1.684 | 3.08 |
| 08/13/00 | 11:15 PM | 6735 | 13.47 | -1.704 | 3.15 |
| 08/13/00 | 11:30 PM | 6750 | 13.55 | -1.697 | 3.13 |
| 08/13/00 | 11:45 PM | 6765 | 13.53 | -1.671 | 3.04 |
| 08/14/00 | 12:00 AM | 6780 | 13.55 | -1.687 | 3.09 |
| 08/14/00 | 12:15 AM | 6795 | 13.61 | -1.71 | 3.17 |
| 08/14/00 | 12:30 AM | 6810 | 13.58 | -1.737 | 3.26 |
| 08/14/00 | 12:45 AM | 6825 | 13.56 | -1.693 | 3.11 |
| 08/14/00 | 01:00 AM | 6840 | 13.59 | -1.685 | 3.09 |
| 08/14/00 | 01:15 AM | 6855 | 13.6 | -1.727 | 3.23 |
| 08/14/00 | 01:30 AM | 6870 | 13.62 | -1.699 | 3.13 |
| 08/14/00 | 01:45 AM | 6885 | 13.62 | -1.701 | 3.14 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL | |
|---|---|---|---|---|---|---|
| 08/14/00 | 02:00 AM | 6900 | 13.64 | -1.725 | 3.22 | |
| 08/14/00 | 02:15 AM | 6915 | 13.63 | -1.737 | 3.26 | |
| 08/14/00 | 02:30 AM | 6930 | 13.6 | -1.727 | 3.23 | |
| 08/14/00 | 02:45 AM | 6945 | 13.6 | -1.742 | 3.27 | high |
| 08/14/00 | 03:00 AM | 6960 | 13.62 | -1.72 | 3.20 | |
| 08/14/00 | 03:15 AM | 6975 | 13.63 | -1.714 | 3.18 | |
| 08/14/00 | 03:30 AM | 6990 | 13.63 | -1.721 | 3.21 | |
| 08/14/00 | 03:45 AM | 7005 | 13.66 | -1.71 | 3.17 | |
| 08/14/00 | 04:00 AM | 7020 | 13.67 | -1.73 | 3.23 | |
| 08/14/00 | 04:15 AM | 7035 | 13.66 | -1.708 | 3.16 | |
| 08/14/00 | 04:30 AM | 7050 | 13.63 | -1.706 | 3.16 | |
| 08/14/00 | 04:45 AM | 7065 | 13.63 | -1.672 | 3.04 | |
| 08/14/00 | 05:00 AM | 7080 | 13.63 | -1.667 | 3.03 | |
| 08/14/00 | 05:15 AM | 7095 | 13.41 | -1.647 | 2.96 | |
| 08/14/00 | 05:30 AM | 7110 | 13.3 | -1.592 | 2.78 | |
| 08/14/00 | 05:45 AM | 7125 | 13.21 | -1.621 | 2.88 | |
| 08/14/00 | 06:00 AM | 7140 | 13.17 | -1.552 | 2.65 | |
| 08/14/00 | 06:15 AM | 7155 | 13.22 | -1.557 | 2.67 | |
| 08/14/00 | 06:30 AM | 7170 | 13.17 | -1.488 | 2.44 | |
| 08/14/00 | 06:45 AM | 7185 | 13.16 | -1.474 | 2.40 | |
| 08/14/00 | 07:00 AM | 7200 | 13.14 | -1.438 | 2.28 | |
| 08/14/00 | 07:15 AM | 7215 | 13.11 | -1.396 | 2.14 | |
| 08/14/00 | 07:30 AM | 7230 | 13.08 | -1.344 | 1.97 | |
| 08/14/00 | 07:45 AM | 7245 | 13.06 | -1.323 | 1.90 | |
| 08/14/00 | 08:00 AM | 7260 | 13.05 | -1.261 | 1.70 | |
| 08/14/00 | 08:15 AM | 7275 | 13.04 | -1.212 | 1.54 | |
| 08/14/00 | 08:30 AM | 7290 | 13.03 | -1.177 | 1.42 | |
| 08/14/00 | 08:45 AM | 7305 | 13.08 | -1.147 | 1.32 | |
| 08/14/00 | 09:00 AM | 7320 | 13.08 | -1.099 | 1.16 | |
| 08/14/00 | 09:15 AM | 7335 | 13.07 | -1.015 | 0.89 | |
| 08/14/00 | 09:30 AM | 7350 | 13.03 | -0.984 | 0.79 | |
| 08/14/00 | 09:45 AM | 7365 | 13.02 | -0.922 | 0.58 | |
| 08/14/00 | 10:00 AM | 7380 | 13.01 | -0.927 | 0.60 | |
| 08/14/00 | 10:15 AM | 7395 | 13.03 | -0.834 | 0.30 | |
| 08/14/00 | 10:30 AM | 7410 | 13.08 | -0.831 | 0.29 | |
| 08/14/00 | 10:45 AM | 7425 | 13.21 | -0.757 | 0.04 | |
| 08/14/00 | 11:00 AM | 7440 | 13.37 | -0.775 | 0.10 | |
| 08/14/00 | 11:15 AM | 7455 | 13.6 | -0.754 | 0.03 | |
| 08/14/00 | 11:30 AM | 7470 | 13.53 | -0.726 | -0.06 | |
| 08/14/00 | 11:45 AM | 7485 | 13.62 | -0.69 | -0.18 | low |
| 08/14/00 | 12:00 PM | 7500 | 13.81 | -0.673 | -0.23 | |
| 08/14/00 | 12:15 PM | 7515 | 13.84 | -0.69 | -0.18 | |
| 08/14/00 | 12:30 PM | 7530 | 13.96 | -0.689 | -0.18 | |
| 08/14/00 | 12:45 PM | 7545 | 13.97 | -0.652 | -0.30 | |
| 08/14/00 | 01:00 PM | 7560 | 14.14 | -0.671 | -0.24 | |
| 08/14/00 | 01:15 PM | 7575 | 14.03 | -0.689 | -0.18 | |
| 08/14/00 | 01:30 PM | 7590 | 14.21 | -0.711 | -0.11 | |
| 08/14/00 | 01:45 PM | 7605 | 14.45 | -0.707 | -0.12 | |
| 08/14/00 | 02:00 PM | 7620 | 14.72 | -0.772 | 0.09 | |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/14/00 | 02:15 PM | 7635 | 15.02 | -0.787 | 0.14 |
| 08/14/00 | 02:30 PM | 7650 | 15.04 | -0.804 | 0.20 |
| 08/14/00 | 02:45 PM | 7665 | 14.78 | -0.837 | 0.31 |
| 08/14/00 | 03:00 PM | 7680 | 14.77 | -0.896 | 0.50 |
| 08/14/00 | 03:15 PM | 7695 | 14.75 | -0.909 | 0.54 |
| 08/14/00 | 03:30 PM | 7710 | 14.93 | -0.944 | 0.66 |
| 08/14/00 | 03:45 PM | 7725 | 14.77 | -1.019 | 0.90 |
| 08/14/00 | 04:00 PM | 7740 | 14.72 | -1.044 | 0.98 |
| 08/14/00 | 04:15 PM | 7755 | 14.71 | -1.081 | 1.11 |
| 08/14/00 | 04:30 PM | 7770 | 14.73 | -1.111 | 1.20 |
| 08/14/00 | 04:45 PM | 7785 | 14.73 | -1.184 | 1.44 |
| 08/14/00 | 05:00 PM | 7800 | 14.96 | -1.183 | 1.44 |
| 08/14/00 | 05:15 PM | 7815 | 15.05 | -1.247 | 1.65 |
| 08/14/00 | 05:30 PM | 7830 | 14.8 | -1.268 | 1.72 |
| 08/14/00 | 05:45 PM | 7845 | 14.42 | -1.337 | 1.95 |
| 08/14/00 | 06:00 PM | 7860 | 14.26 | -1.375 | 2.07 |
| 08/14/00 | 06:15 PM | 7875 | 14.16 | -1.419 | 2.21 |
| 08/14/00 | 06:30 PM | 7890 | 13.94 | -1.441 | 2.29 |
| 08/14/00 | 06:45 PM | 7905 | 13.83 | -1.493 | 2.46 |
| 08/14/00 | 07:00 PM | 7920 | 13.79 | -1.528 | 2.57 |
| 08/14/00 | 07:15 PM | 7935 | 13.8 | -1.524 | 2.56 |
| 08/14/00 | 07:30 PM | 7950 | 13.76 | -1.528 | 2.57 |
| 08/14/00 | 07:45 PM | 7965 | 13.27 | -1.601 | 2.81 |
| 08/14/00 | 08:00 PM | 7980 | 13.3 | -1.627 | 2.90 |
| 08/14/00 | 08:15 PM | 7995 | 13.32 | -1.634 | 2.92 |
| 08/14/00 | 08:30 PM | 8010 | 13.3 | -1.679 | 3.07 |
| 08/14/00 | 08:45 PM | 8025 | 13.27 | -1.635 | 2.92 |
| 08/14/00 | 09:00 PM | 8040 | 13.29 | -1.701 | 3.14 |
| 08/14/00 | 09:15 PM | 8055 | 13.76 | -1.704 | 3.15 |
| 08/14/00 | 09:30 PM | 8070 | 13.8 | -1.69 | 3.10 |
| 08/14/00 | 09:45 PM | 8085 | 13.57 | -1.688 | 3.10 |
| 08/14/00 | 10:00 PM | 8100 | 13.65 | -1.694 | 3.12 |
| 08/14/00 | 10:15 PM | 8115 | 13.7 | -1.693 | 3.11 |
| 08/14/00 | 10:30 PM | 8130 | 13.76 | -1.694 | 3.12 |
| 08/14/00 | 10:45 PM | 8145 | 13.75 | -1.686 | 3.09 |
| 08/14/00 | 11:00 PM | 8160 | 13.69 | -1.707 | 3.16 |
| 08/14/00 | 11:15 PM | 8175 | 13.66 | -1.701 | 3.14 |
| 08/14/00 | 11:30 PM | 8190 | 13.65 | -1.68 | 3.07 |
| 08/14/00 | 11:45 PM | 8205 | 13.65 | -1.703 | 3.15 |
| 08/15/00 | 12:00 AM | 8220 | 13.62 | -1.69 | 3.10 |
| 08/15/00 | 12:15 AM | 8235 | 13.54 | -1.704 | 3.15 |
| 08/15/00 | 12:30 AM | 8250 | 13.54 | -1.697 | 3.13 |
| 08/15/00 | 12:45 AM | 8265 | 13.53 | -1.671 | 3.04 |
| 08/15/00 | 01:00 AM | 8280 | 13.59 | -1.723 | 3.21 |
| 08/15/00 | 01:15 AM | 8295 | 13.57 | -1.692 | 3.11 |
| 08/15/00 | 01:30 AM | 8310 | 13.57 | -1.688 | 3.10 |
| 08/15/00 | 01:45 AM | 8325 | 13.53 | -1.704 | 3.15 |
| 08/15/00 | 02:00 AM | 8340 | 13.65 | -1.689 | 3.10 |
| 08/15/00 | 02:15 AM | 8355 | 13.61 | -1.718 | 3.20 |
| 08/15/00 | 02:30 AM | 8370 | 13.53 | -1.717 | 3.19 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL | |
|---|---|---|---|---|---|---|
| 08/15/00 | 02:45 AM | 8385 | 13.45 | -1.711 | 3.17 | |
| 08/15/00 | 03:00 AM | 8400 | 13.4 | -1.726 | 3.22 | high |
| 08/15/00 | 03:15 AM | 8415 | 13.39 | -1.706 | 3.16 | |
| 08/15/00 | 03:30 AM | 8430 | 12.31 | -1.694 | 3.12 | |
| 08/15/00 | 03:45 AM | 8445 | 10.63 | -1.689 | 3.10 | |
| 08/15/00 | 04:00 AM | 8460 | 10.1 | -1.704 | 3.15 | |
| 08/15/00 | 04:15 AM | 8475 | 9.69 | -1.708 | 3.16 | |
| 08/15/00 | 04:30 AM | 8490 | 10.09 | -1.692 | 3.11 | |
| 08/15/00 | 04:45 AM | 8505 | 11.91 | -1.68 | 3.07 | |
| 08/15/00 | 05:00 AM | 8520 | 12.88 | -1.681 | 3.07 | |
| 08/15/00 | 05:15 AM | 8535 | 13.02 | -1.644 | 2.95 | |
| 08/15/00 | 05:30 AM | 8550 | 13.07 | -1.654 | 2.99 | |
| 08/15/00 | 05:45 AM | 8565 | 12.87 | -1.623 | 2.88 | |
| 08/15/00 | 06:00 AM | 8580 | 12.79 | -1.609 | 2.84 | |
| 08/15/00 | 06:15 AM | 8595 | 12.8 | -1.562 | 2.68 | |
| 08/15/00 | 06:30 AM | 8610 | 11.4 | -1.559 | 2.67 | |
| 08/15/00 | 06:45 AM | 8625 | 10.12 | -1.535 | 2.60 | |
| 08/15/00 | 07:00 AM | 8640 | 9.58 | -1.493 | 2.46 | |
| 08/15/00 | 07:15 AM | 8655 | 9.39 | -1.479 | 2.41 | |
| 08/15/00 | 07:30 AM | 8670 | 9.37 | -1.419 | 2.21 | |
| 08/15/00 | 07:45 AM | 8685 | 9.88 | -1.41 | 2.19 | |
| 08/15/00 | 08:00 AM | 8700 | 11.34 | -1.36 | 2.02 | |
| 08/15/00 | 08:15 AM | 8715 | 12.04 | -1.306 | 1.84 | |
| 08/15/00 | 08:30 AM | 8730 | 10.85 | -1.28 | 1.76 | |
| 08/15/00 | 08:45 AM | 8745 | 10.65 | -1.266 | 1.71 | |
| 08/15/00 | 09:00 AM | 8760 | 10.83 | -1.208 | 1.52 | |
| 08/15/00 | 09:15 AM | 8775 | 10.14 | -1.164 | 1.38 | |
| 08/15/00 | 09:30 AM | 8790 | 9.82 | -1.112 | 1.21 | |
| 08/15/00 | 09:45 AM | 8805 | 10.04 | -1.097 | 1.16 | |
| 08/15/00 | 10:00 AM | 8820 | 11.71 | -1.063 | 1.05 | |
| 08/15/00 | 10:15 AM | 8835 | 12.36 | -0.982 | 0.78 | |
| 08/15/00 | 10:30 AM | 8850 | 12.54 | -0.963 | 0.72 | |
| 08/15/00 | 10:45 AM | 8865 | 12.58 | -0.936 | 0.63 | |
| 08/15/00 | 11:00 AM | 8880 | 12.9 | -0.89 | 0.48 | |
| 08/15/00 | 11:15 AM | 8895 | 12.94 | -0.841 | 0.32 | |
| 08/15/00 | 11:30 AM | 8910 | 13.06 | -0.848 | 0.34 | |
| 08/15/00 | 11:45 AM | 8925 | 13.12 | -0.793 | 0.16 | |
| 08/15/00 | 12:00 PM | 8940 | 13.21 | -0.79 | 0.15 | |
| 08/15/00 | 12:15 PM | 8955 | 13.35 | -0.771 | 0.09 | |
| 08/15/00 | 12:30 PM | 8970 | 13.44 | -0.736 | -0.03 | |
| 08/15/00 | 12:45 PM | 8985 | 13.67 | -0.744 | 0.00 | |
| 08/15/00 | 01:00 PM | 9000 | 14.04 | -0.745 | 0.00 | |
| 08/15/00 | 01:15 PM | 9015 | 14.27 | -0.727 | -0.06 | |
| 08/15/00 | 01:30 PM | 9030 | 14.06 | -0.742 | -0.01 | |
| 08/15/00 | 01:45 PM | 9045 | 13.9 | -0.734 | -0.03 | low |
| 08/15/00 | 02:00 PM | 9060 | 14.09 | -0.745 | 0.00 | |
| 08/15/00 | 02:15 PM | 9075 | 14.09 | -0.754 | 0.03 | |
| 08/15/00 | 02:30 PM | 9090 | 14.14 | -0.776 | 0.10 | |
| 08/15/00 | 02:45 PM | 9105 | 14.26 | -0.815 | 0.23 | |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/15/00 | 03:00 PM | 9120 | 12.68 | -0.792 | 0.16 |
| 08/15/00 | 03:15 PM | 9135 | 11.54 | -0.865 | 0.40 |
| 08/15/00 | 03:30 PM | 9150 | 11.31 | -0.893 | 0.49 |
| 08/15/00 | 03:45 PM | 9165 | 10.76 | -0.889 | 0.48 |
| 08/15/00 | 04:00 PM | 9180 | 10.54 | -0.932 | 0.62 |
| 08/15/00 | 04:15 PM | 9195 | 10.31 | -1.008 | 0.87 |
| 08/15/00 | 04:30 PM | 9210 | 10.14 | -1.057 | 1.03 |
| 08/15/00 | 04:45 PM | 9225 | 10.15 | -1.034 | 0.95 |
| 08/15/00 | 05:00 PM | 9240 | 10.25 | -1.113 | 1.21 |
| 08/15/00 | 05:15 PM | 9255 | 9.93 | -1.174 | 1.41 |
| 08/15/00 | 05:30 PM | 9270 | 9.72 | -1.201 | 1.50 |
| 08/15/00 | 05:45 PM | 9285 | 9.26 | -1.223 | 1.57 |
| 08/15/00 | 06:00 PM | 9300 | 9.01 | -1.289 | 1.79 |
| 08/15/00 | 06:15 PM | 9315 | 8.9 | -1.339 | 1.95 |
| 08/15/00 | 06:30 PM | 9330 | 8.85 | -1.336 | 1.94 |
| 08/15/00 | 06:45 PM | 9345 | 9.12 | -1.364 | 2.03 |
| 08/15/00 | 07:00 PM | 9360 | 9.4 | -1.486 | 2.43 |
| 08/15/00 | 07:15 PM | 9375 | 11.06 | -1.496 | 2.47 |
| 08/15/00 | 07:30 PM | 9390 | 12.4 | -1.514 | 2.53 |
| 08/15/00 | 07:45 PM | 9405 | 12.79 | -1.505 | 2.50 |
| 08/15/00 | 08:00 PM | 9420 | 12.42 | -1.595 | 2.79 |
| 08/15/00 | 08:15 PM | 9435 | 11.98 | -1.602 | 2.81 |
| 08/15/00 | 08:30 PM | 9450 | 11.43 | -1.614 | 2.85 |
| 08/15/00 | 08:45 PM | 9465 | 10.88 | -1.657 | 3.00 |
| 08/15/00 | 09:00 PM | 9480 | 10.68 | -1.637 | 2.93 |
| 08/15/00 | 09:15 PM | 9495 | 10.71 | -1.654 | 2.99 |
| 08/15/00 | 09:30 PM | 9510 | 10.73 | -1.65 | 2.97 |
| 08/15/00 | 09:45 PM | 9525 | 10.97 | -1.655 | 2.99 |
| 08/15/00 | 10:00 PM | 9540 | 11.08 | -1.661 | 3.01 |
| 08/15/00 | 10:15 PM | 9555 | 11.24 | -1.668 | 3.03 |
| 08/15/00 | 10:30 PM | 9570 | 11.56 | -1.647 | 2.96 |
| 08/15/00 | 10:45 PM | 9585 | 11.62 | -1.683 | 3.08 |
| 08/15/00 | 11:00 PM | 9600 | 11.73 | -1.655 | 2.99 |
| 08/15/00 | 11:15 PM | 9615 | 11.77 | -1.677 | 3.06 |
| 08/15/00 | 11:30 PM | 9630 | 11.53 | -1.659 | 3.00 |
| 08/15/00 | 11:45 PM | 9645 | 11.38 | -1.664 | 3.02 |
| 08/16/00 | 12:00 AM | 9660 | 11.34 | -1.639 | 2.94 |
| 08/16/00 | 12:15 AM | 9675 | 11.26 | -1.654 | 2.99 |
| 08/16/00 | 12:30 AM | 9690 | 11.2 | -1.649 | 2.97 |
| 08/16/00 | 12:45 AM | 9705 | 11.08 | -1.62 | 2.87 |
| 08/16/00 | 01:00 AM | 9720 | 10.96 | -1.652 | 2.98 |
| 08/16/00 | 01:15 AM | 9735 | 10.8 | -1.64 | 2.94 |
| 08/16/00 | 01:30 AM | 9750 | 10.74 | -1.647 | 2.96 |
| 08/16/00 | 01:45 AM | 9765 | 10.65 | -1.617 | 2.86 |
| 08/16/00 | 02:00 AM | 9780 | 10.42 | -1.633 | 2.92 |
| 08/16/00 | 02:15 AM | 9795 | 10.28 | -1.59 | 2.78 |
| 08/16/00 | 02:30 AM | 9810 | 10.2 | -1.609 | 2.84 |
| 08/16/00 | 02:45 AM | 9825 | 9.96 | -1.604 | 2.82 |
| 08/16/00 | 03:00 AM | 9840 | 9.78 | -1.602 | 2.81 |
| 08/16/00 | 03:15 AM | 9855 | 9.74 | -1.609 | 2.84 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL | |
|---|---|---|---|---|---|---|
| 08/16/00 | 03:30 AM | 9870 | 9.72 | -1.593 | 2.79 | |
| 08/16/00 | 03:45 AM | 9885 | 9.81 | -1.585 | 2.76 | |
| 08/16/00 | 04:00 AM | 9900 | 11.05 | -1.611 | 2.84 | |
| 08/16/00 | 04:15 AM | 9915 | 11.26 | -1.604 | 2.82 | high |
| 08/16/00 | 04:30 AM | 9930 | 11.32 | -1.592 | 2.78 | |
| 08/16/00 | 04:45 AM | 9945 | 11.08 | -1.592 | 2.78 | |
| 08/16/00 | 05:00 AM | 9960 | 10.73 | -1.609 | 2.84 | |
| 08/16/00 | 05:15 AM | 9975 | 10.49 | -1.585 | 2.76 | |
| 08/16/00 | 05:30 AM | 9990 | 10.44 | -1.577 | 2.73 | |
| 08/16/00 | 05:45 AM | 10005 | 10.35 | -1.598 | 2.80 | |
| 08/16/00 | 06:00 AM | 10020 | 10.15 | -1.589 | 2.77 | |
| 08/16/00 | 06:15 AM | 10035 | 9.86 | -1.544 | 2.62 | |
| 08/16/00 | 06:30 AM | 10050 | 9.75 | -1.526 | 2.57 | |
| 08/16/00 | 06:45 AM | 10065 | 9.75 | -1.528 | 2.57 | |
| 08/16/00 | 07:00 AM | 10080 | 9.75 | -1.502 | 2.49 | |
| 08/16/00 | 07:15 AM | 10095 | 9.76 | -1.466 | 2.37 | |
| 08/16/00 | 07:30 AM | 10110 | 9.72 | -1.474 | 2.40 | |
| 08/16/00 | 07:45 AM | 10125 | 9.71 | -1.432 | 2.26 | |
| 08/16/00 | 08:00 AM | 10140 | 9.88 | -1.41 | 2.19 | |
| 08/16/00 | 08:15 AM | 10155 | 10.1 | -1.369 | 2.05 | |
| 08/16/00 | 08:30 AM | 10170 | 10.22 | -1.35 | 1.99 | |
| 08/16/00 | 08:45 AM | 10185 | 10 | -1.323 | 1.90 | |
| 08/16/00 | 09:00 AM | 10200 | 9.93 | -1.271 | 1.73 | |
| 08/16/00 | 09:15 AM | 10215 | 9.98 | -1.28 | 1.76 | |
| 08/16/00 | 09:30 AM | 10230 | 9.91 | -1.216 | 1.55 | |
| 08/16/00 | 09:45 AM | 10245 | 9.88 | -1.181 | 1.43 | |
| 08/16/00 | 10:00 AM | 10260 | 9.87 | -1.139 | 1.30 | |
| 08/16/00 | 10:15 AM | 10275 | 9.88 | -1.116 | 1.22 | |
| 08/16/00 | 10:30 AM | 10290 | 9.95 | -1.091 | 1.14 | |
| 08/16/00 | 10:45 AM | 10305 | 9.96 | -1.024 | 0.92 | |
| 08/16/00 | 11:00 AM | 10320 | 9.98 | -0.992 | 0.81 | |
| 08/16/00 | 11:15 AM | 10335 | 9.83 | -0.977 | 0.76 | |
| 08/16/00 | 11:30 AM | 10350 | 9.74 | -0.939 | 0.64 | |
| 08/16/00 | 11:45 AM | 10365 | 9.63 | -0.896 | 0.50 | |
| 08/16/00 | 12:00 PM | 10380 | 9.21 | -0.879 | 0.44 | |
| 08/16/00 | 12:15 PM | 10395 | 8.71 | -0.863 | 0.39 | |
| 08/16/00 | 12:30 PM | 10410 | 8.53 | -0.843 | 0.32 | |
| 08/16/00 | 12:45 PM | 10425 | 8.49 | -0.825 | 0.27 | |
| 08/16/00 | 01:00 PM | 10440 | 8.49 | -0.799 | 0.18 | |
| 08/16/00 | 01:15 PM | 10455 | 8.39 | -0.835 | 0.30 | |
| 08/16/00 | 01:30 PM | 10470 | 8.37 | -0.794 | 0.16 | |
| 08/16/00 | 01:45 PM | 10485 | 8.35 | -0.792 | 0.16 | |
| 08/16/00 | 02:00 PM | 10500 | 8.43 | -0.783 | 0.13 | |
| 08/16/00 | 02:15 PM | 10515 | 8.43 | -0.799 | 0.18 | |
| 08/16/00 | 02:30 PM | 10530 | 8.41 | -0.776 | 0.10 | |
| 08/16/00 | 02:45 PM | 10545 | 8.38 | -0.816 | 0.24 | |
| 08/16/00 | 03:00 PM | 10560 | 8.43 | -0.843 | 0.32 | |
| 08/16/00 | 03:15 PM | 10575 | 8.43 | -0.84 | 0.31 | |
| 08/16/00 | 03:30 PM | 10590 | 8.29 | -0.85 | 0.35 | |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/16/00 | 03:45 PM | 10605 | 8.19 | -0.913 | 0.55 |
| 08/16/00 | 04:00 PM | 10620 | 8.28 | -0.939 | 0.64 |
| 08/16/00 | 04:15 PM | 10635 | 8.29 | -0.941 | 0.65 |
| 08/16/00 | 04:30 PM | 10650 | 8.34 | -0.962 | 0.72 |
| 08/16/00 | 04:45 PM | 10665 | 8.35 | -1.017 | 0.90 |
| 08/16/00 | 05:00 PM | 10680 | 8.51 | -1.053 | 1.01 |
| 08/16/00 | 05:15 PM | 10695 | 8.52 | -1.073 | 1.08 |
| 08/16/00 | 05:30 PM | 10710 | 8.45 | -1.116 | 1.22 |
| 08/16/00 | 05:45 PM | 10725 | 8.51 | -1.161 | 1.37 |
| 08/16/00 | 06:00 PM | 10740 | 8.5 | -1.205 | 1.51 |
| 08/16/00 | 06:15 PM | 10755 | 8.54 | -1.221 | 1.56 |
| 08/16/00 | 06:30 PM | 10770 | 8.57 | -1.297 | 1.81 |
| 08/16/00 | 06:45 PM | 10785 | 8.57 | -1.328 | 1.92 |
| 08/16/00 | 07:00 PM | 10800 | 8.53 | -1.345 | 1.97 |
| 08/16/00 | 07:15 PM | 10815 | 8.51 | -1.393 | 2.13 |
| 08/16/00 | 07:30 PM | 10830 | 8.56 | -1.45 | 2.32 |
| 08/16/00 | 07:45 PM | 10845 | 8.62 | -1.49 | 2.45 |
| 08/16/00 | 08:00 PM | 10860 | 8.65 | -1.479 | 2.41 |
| 08/16/00 | 08:15 PM | 10875 | 8.62 | -1.534 | 2.59 |
| 08/16/00 | 08:30 PM | 10890 | 8.62 | -1.55 | 2.64 |
| 08/16/00 | 08:45 PM | 10905 | 8.6 | -1.569 | 2.71 |
| 08/16/00 | 09:00 PM | 10920 | 8.59 | -1.586 | 2.76 |
| 08/16/00 | 09:15 PM | 10935 | 8.56 | -1.639 | 2.94 |
| 08/16/00 | 09:30 PM | 10950 | 8.53 | -1.635 | 2.92 |
| 08/16/00 | 09:45 PM | 10965 | 8.53 | -1.64 | 2.94 |
| 08/16/00 | 10:00 PM | 10980 | 8.5 | -1.64 | 2.94 |
| 08/16/00 | 10:15 PM | 10995 | 8.5 | -1.657 | 3.00 |
| 08/16/00 | 10:30 PM | 11010 | 8.48 | -1.652 | 2.98 |
| 08/16/00 | 10:45 PM | 11025 | 8.45 | -1.655 | 2.99 |
| 08/16/00 | 11:00 PM | 11040 | 8.41 | -1.648 | 2.97 |
| 08/16/00 | 11:15 PM | 11055 | 8.41 | -1.63 | 2.91 |
| 08/16/00 | 11:30 PM | 11070 | 8.41 | -1.627 | 2.90 |
| 08/16/00 | 11:45 PM | 11085 | 8.4 | -1.618 | 2.87 |
| 08/17/00 | 12:00 AM | 11100 | 8.37 | -1.607 | 2.83 |
| 08/17/00 | 12:15 AM | 11115 | 8.34 | -1.599 | 2.81 |
| 08/17/00 | 12:30 AM | 11130 | 8.32 | -1.598 | 2.80 |
| 08/17/00 | 12:45 AM | 11145 | 8.29 | -1.623 | 2.88 |
| 08/17/00 | 01:00 AM | 11160 | 8.26 | -1.553 | 2.65 |
| 08/17/00 | 01:15 AM | 11175 | 8.24 | -1.569 | 2.71 |
| 08/17/00 | 01:30 AM | 11190 | 8.24 | -1.564 | 2.69 |
| 08/17/00 | 01:45 AM | 11205 | 8.24 | -1.569 | 2.71 |
| 08/17/00 | 02:00 AM | 11220 | 8.24 | -1.528 | 2.57 |
| 08/17/00 | 02:15 AM | 11235 | 8.24 | -1.549 | 2.64 |
| 08/17/00 | 02:30 AM | 11250 | 8.23 | -1.521 | 2.55 |
| 08/17/00 | 02:45 AM | 11265 | 8.23 | -1.505 | 2.50 |
| 08/17/00 | 03:00 AM | 11280 | 8.23 | -1.506 | 2.50 |
| 08/17/00 | 03:15 AM | 11295 | 8.22 | -1.474 | 2.40 |
| 08/17/00 | 03:30 AM | 11310 | 8.24 | -1.492 | 2.45 |
| 08/17/00 | 03:45 AM | 11325 | 8.26 | -1.465 | 2.37 |
| 08/17/00 | 04:00 AM | 11340 | 8.27 | -1.495 | 2.46 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/17/00 | 04:15 AM | 11355 | 8.29 | -1.455 | 2.33 |
| 08/17/00 | 04:30 AM | 11370 | 8.3 | -1.507 | 2.50 |
| 08/17/00 | 04:45 AM | 11385 | 8.31 | -1.491 | 2.45 |
| 08/17/00 | 05:00 AM | 11400 | 8.3 | -1.498 | 2.47 |
| 08/17/00 | 05:15 AM | 11415 | 8.32 | -1.481 | 2.42 |
| 08/17/00 | 05:30 AM | 11430 | 8.37 | -1.511 | 2.52 |
| 08/17/00 | 05:45 AM | 11445 | 8.38 | -1.489 | 2.44 |
| 08/17/00 | 06:00 AM | 11460 | 8.41 | -1.493 | 2.46 |
| 08/17/00 | 06:15 AM | 11475 | 8.42 | -1.488 | 2.44 |
| 08/17/00 | 06:30 AM | 11490 | 8.47 | -1.479 | 2.41 |
| 08/17/00 | 06:45 AM | 11505 | 8.53 | -1.462 | 2.36 |
| 08/17/00 | 07:00 AM | 11520 | 8.62 | -1.459 | 2.35 |
| 08/17/00 | 07:15 AM | 11535 | 8.62 | -1.474 | 2.40 |
| 08/17/00 | 07:30 AM | 11550 | 8.6 | -1.415 | 2.20 |
| 08/17/00 | 07:45 AM | 11565 | 8.55 | -1.423 | 2.23 |
| 08/17/00 | 08:00 AM | 11580 | 8.5 | -1.413 | 2.19 |
| 08/17/00 | 08:15 AM | 11595 | 8.49 | -1.431 | 2.25 |
| 08/17/00 | 08:30 AM | 11610 | 8.53 | -1.392 | 2.13 |
| 08/17/00 | 08:45 AM | 11625 | 8.57 | -1.358 | 2.01 |
| 08/17/00 | 09:00 AM | 11640 | 8.51 | -1.339 | 1.95 |
| 08/17/00 | 09:15 AM | 11655 | 8.47 | -1.332 | 1.93 |
| 08/17/00 | 09:30 AM | 11670 | 8.52 | -1.27 | 1.73 |
| 08/17/00 | 09:45 AM | 11685 | 8.57 | -1.253 | 1.67 |
| 08/17/00 | 10:00 AM | 11700 | 8.57 | -1.228 | 1.59 |
| 08/17/00 | 10:15 AM | 11715 | 8.56 | -1.226 | 1.58 |
| 08/17/00 | 10:30 AM | 11730 | 8.61 | -1.185 | 1.45 |
| 08/17/00 | 10:45 AM | 11745 | 8.64 | -1.131 | 1.27 |
| 08/17/00 | 11:00 AM | 11760 | 8.65 | -1.116 | 1.22 |
| 08/17/00 | 11:15 AM | 11775 | 8.7 | -1.105 | 1.18 |
| 08/17/00 | 11:30 AM | 11790 | 8.78 | -1.061 | 1.04 |
| 08/17/00 | 11:45 AM | 11805 | 8.81 | -1.03 | 0.94 |
| 08/17/00 | 12:00 PM | 11820 | 8.9 | -0.996 | 0.83 |
| 08/17/00 | 12:15 PM | 11835 | 8.93 | -0.965 | 0.73 |
| 08/17/00 | 12:30 PM | 11850 | 8.89 | -0.938 | 0.64 |
| 08/17/00 | 12:45 PM | 11865 | 8.79 | -0.943 | 0.65 |
| 08/17/00 | 01:00 PM | 11880 | 8.81 | -0.898 | 0.51 |
| 08/17/00 | 01:15 PM | 11895 | 8.77 | -0.905 | 0.53 |
| 08/17/00 | 01:30 PM | 11910 | 8.76 | -0.877 | 0.44 |
| 08/17/00 | 01:45 PM | 11925 | 8.97 | -0.856 | 0.37 |
| 08/17/00 | 02:00 PM | 11940 | 9.3 | -0.861 | 0.38 |
| 08/17/00 | 02:15 PM | 11955 | 9.62 | -0.846 | 0.33 |
| 08/17/00 | 02:30 PM | 11970 | 9.87 | -0.86 | 0.38 |
| 08/17/00 | 02:45 PM | 11985 | 10.11 | -0.846 | 0.33 |
| 08/17/00 | 03:00 PM | 12000 | 10.35 | -0.834 | 0.30 |
| 08/17/00 | 03:15 PM | 12015 | 10.63 | -0.837 | 0.31 |
| 08/17/00 | 03:30 PM | 12030 | 11.17 | -0.872 | 0.42 |
| 08/17/00 | 03:45 PM | 12045 | 11.16 | -0.876 | 0.43 |
| 08/17/00 | 04:00 PM | 12060 | 11.18 | -0.9 | 0.51 |
| 08/17/00 | 04:15 PM | 12075 | 11.34 | -0.927 | 0.60 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/17/00 | 04:30 PM | 12090 | 11.35 | -0.989 | 0.80 |
| 08/17/00 | 04:45 PM | 12105 | 11.05 | -0.966 | 0.73 |
| 08/17/00 | 05:00 PM | 12120 | 10.83 | -1.003 | 0.85 |
| 08/17/00 | 05:15 PM | 12135 | 10.81 | -1.046 | 0.99 |
| 08/17/00 | 05:30 PM | 12150 | 10.87 | -1.082 | 1.11 |
| 08/17/00 | 05:45 PM | 12165 | 10.83 | -1.093 | 1.15 |
| 08/17/00 | 06:00 PM | 12180 | 10.78 | -1.119 | 1.23 |
| 08/17/00 | 06:15 PM | 12195 | 10.8 | -1.197 | 1.49 |
| 08/17/00 | 06:30 PM | 12210 | 10.83 | -1.209 | 1.53 |
| 08/17/00 | 06:45 PM | 12225 | 10.81 | -1.265 | 1.71 |
| 08/17/00 | 07:00 PM | 12240 | 10.79 | -1.277 | 1.75 |
| 08/17/00 | 07:15 PM | 12255 | 10.84 | -1.357 | 2.01 |
| 08/17/00 | 07:30 PM | 12270 | 10.97 | -1.316 | 1.88 |
| 08/17/00 | 07:45 PM | 12285 | 10.97 | -1.375 | 2.07 |
| 08/17/00 | 08:00 PM | 12300 | 11.01 | -1.446 | 2.30 |
| 08/17/00 | 08:15 PM | 12315 | 11.13 | -1.478 | 2.41 |
| 08/17/00 | 08:30 PM | 12330 | 11.24 | -1.484 | 2.43 |
| 08/17/00 | 08:45 PM | 12345 | 11.2 | -1.502 | 2.49 |
| 08/17/00 | 09:00 PM | 12360 | 11.17 | -1.535 | 2.60 |
| 08/17/00 | 09:15 PM | 12375 | 11.11 | -1.59 | 2.78 |
| 08/17/00 | 09:30 PM | 12390 | 11.08 | -1.591 | 2.78 |
| 08/17/00 | 09:45 PM | 12405 | 11.06 | -1.616 | 2.86 |
| 08/17/00 | 10:00 PM | 12420 | 11.08 | -1.607 | 2.83 |
| 08/17/00 | 10:15 PM | 12435 | 11.07 | -1.604 | 2.82 |
| 08/17/00 | 10:30 PM | 12450 | 10.99 | -1.623 | 2.88 |
| 08/17/00 | 10:45 PM | 12465 | 10.91 | -1.615 | 2.86 |
| 08/17/00 | 11:00 PM | 12480 | 10.71 | -1.623 | 2.88 |
| 08/17/00 | 11:15 PM | 12495 | 10.32 | -1.587 | 2.77 |
| 08/17/00 | 11:30 PM | 12510 | 10 | -1.564 | 2.69 |
| 08/17/00 | 11:45 PM | 12525 | 9.84 | -1.585 | 2.76 |
| 08/18/00 | 12:00 AM | 12540 | 9.69 | -1.544 | 2.62 |
| 08/18/00 | 12:15 AM | 12555 | 9.65 | -1.521 | 2.55 |
| 08/18/00 | 12:30 AM | 12570 | 9.68 | -1.527 | 2.57 |
| 08/18/00 | 12:45 AM | 12585 | 10.04 | -1.512 | 2.52 |
| 08/18/00 | 01:00 AM | 12600 | 10.12 | -1.517 | 2.54 |
| 08/18/00 | 01:15 AM | 12615 | 10.24 | -1.493 | 2.46 |
| 08/18/00 | 01:30 AM | 12630 | 10.41 | -1.479 | 2.41 |
| 08/18/00 | 01:45 AM | 12645 | 10.59 | -1.475 | 2.40 |
| 08/18/00 | 02:00 AM | 12660 | 11.04 | -1.457 | 2.34 |
| 08/18/00 | 02:15 AM | 12675 | 11.18 | -1.441 | 2.29 |
| 08/18/00 | 02:30 AM | 12690 | 11.19 | -1.451 | 2.32 |
| 08/18/00 | 02:45 AM | 12705 | 11.23 | -1.398 | 2.15 |
| 08/18/00 | 03:00 AM | 12720 | 11.25 | -1.385 | 2.10 |
| 08/18/00 | 03:15 AM | 12735 | 11.26 | -1.356 | 2.01 |
| 08/18/00 | 03:30 AM | 12750 | 11.29 | -1.341 | 1.96 |
| 08/18/00 | 03:45 AM | 12765 | 11.28 | -1.356 | 2.01 |
| 08/18/00 | 04:00 AM | 12780 | 11.3 | -1.348 | 1.98 |
| 08/18/00 | 04:15 AM | 12795 | 11.29 | -1.306 | 1.84 |
| 08/18/00 | 04:30 AM | 12810 | 11.32 | -1.347 | 1.98 |
| 08/18/00 | 04:45 AM | 12825 | 11.32 | -1.346 | 1.98 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/18/00 | 05:00 AM | 12840 | 11.33 | -1.37 | 2.05 |
| 08/18/00 | 05:15 AM | 12855 | 11.29 | -1.361 | 2.02 |
| 08/18/00 | 05:30 AM | 12870 | 11.16 | -1.398 | 2.15 |
| 08/18/00 | 05:45 AM | 12885 | 11.16 | -1.375 | 2.07 |
| 08/18/00 | 06:00 AM | 12900 | 11.01 | -1.389 | 2.12 |
| 08/18/00 | 06:15 AM | 12915 | 10.7 | -1.352 | 1.99 |
| 08/18/00 | 06:30 AM | 12930 | 10.62 | -1.409 | 2.18 |
| 08/18/00 | 06:45 AM | 12945 | 10.63 | -1.398 | 2.15 |
| 08/18/00 | 07:00 AM | 12960 | 10.7 | -1.388 | 2.11 |
| 08/18/00 | 07:15 AM | 12975 | 10.79 | -1.388 | 2.11 |
| 08/18/00 | 07:30 AM | 12990 | 10.81 | -1.398 | 2.15 |
| 08/18/00 | 07:45 AM | 13005 | 10.81 | -1.416 | 2.20 |
| 08/18/00 | 08:00 AM | 13020 | 10.83 | -1.378 | 2.08 |
| 08/18/00 | 08:15 AM | 13035 | 10.85 | -1.398 | 2.15 |
| 08/18/00 | 08:30 AM | 13050 | 10.78 | -1.386 | 2.11 |
| 08/18/00 | 08:45 AM | 13065 | 10.37 | -1.383 | 2.10 |
| 08/18/00 | 09:00 AM | 13080 | 10.17 | -1.388 | 2.11 |
| 08/18/00 | 09:15 AM | 13095 | 9.95 | -1.376 | 2.07 |
| 08/18/00 | 09:30 AM | 13110 | 10.03 | -1.358 | 2.01 |
| 08/18/00 | 09:45 AM | 13125 | 10.02 | -1.369 | 2.05 |
| 08/18/00 | 10:00 AM | 13140 | 10.01 | -1.334 | 1.94 |
| 08/18/00 | 10:15 AM | 13155 | 10.16 | -1.318 | 1.88 |
| 08/18/00 | 10:30 AM | 13170 | 10.26 | -1.279 | 1.76 |
| 08/18/00 | 10:45 AM | 13185 | 10.33 | -1.256 | 1.68 |
| 08/18/00 | 11:00 AM | 13200 | 10.34 | -1.268 | 1.72 |
| 08/18/00 | 11:15 AM | 13215 | 10.39 | -1.237 | 1.62 |
| 08/18/00 | 11:30 AM | 13230 | 10.56 | -1.18 | 1.43 |
| 08/18/00 | 11:45 AM | 13245 | 10.76 | -1.165 | 1.38 |
| 08/18/00 | 12:00 PM | 13260 | 10.86 | -1.149 | 1.33 |
| 08/18/00 | 12:15 PM | 13275 | 10.97 | -1.108 | 1.19 |
| 08/18/00 | 12:30 PM | 13290 | 11.09 | -1.084 | 1.12 |
| 08/18/00 | 12:45 PM | 13305 | 11.24 | -1.069 | 1.07 |
| 08/18/00 | 01:00 PM | 13320 | 11.34 | -1.028 | 0.93 |
| 08/18/00 | 01:15 PM | 13335 | 11.43 | -1.017 | 0.90 |
| 08/18/00 | 01:30 PM | 13350 | 11.52 | -0.977 | 0.76 |
| 08/18/00 | 01:45 PM | 13365 | 11.59 | -0.989 | 0.80 |
| 08/18/00 | 02:00 PM | 13380 | 11.63 | -0.962 | 0.72 |
| 08/18/00 | 02:15 PM | 13395 | 11.65 | -0.946 | 0.66 |
| 08/18/00 | 02:30 PM | 13410 | 11.69 | -0.961 | 0.71 |
| 08/18/00 | 02:45 PM | 13425 | 11.75 | -0.94 | 0.64 |
| 08/18/00 | 03:00 PM | 13440 | 11.99 | -0.951 | 0.68 |
| 08/18/00 | 03:15 PM | 13455 | 12.41 | -0.944 | 0.66 |
| 08/18/00 | 03:30 PM | 13470 | 12.48 | -0.95 | 0.68 |
| 08/18/00 | 03:45 PM | 13485 | 12.16 | -0.952 | 0.68 |
| 08/18/00 | 04:00 PM | 13500 | 12.07 | -0.984 | 0.79 |
| 08/18/00 | 04:15 PM | 13515 | 12.1 | -0.965 | 0.73 |
| 08/18/00 | 04:30 PM | 13530 | 12.14 | -0.995 | 0.82 |
| 08/18/00 | 04:45 PM | 13545 | 12.15 | -1.009 | 0.87 |
| 08/18/00 | 05:00 PM | 13560 | 12.14 | -1.002 | 0.85 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/18/00 | 05:15 PM | 13575 | 12.17 | -1.023 | 0.92 |
| 08/18/00 | 05:30 PM | 13590 | 12.49 | -1.043 | 0.98 |
| 08/18/00 | 05:45 PM | 13605 | 12.5 | -1.099 | 1.16 |
| 08/18/00 | 06:00 PM | 13620 | 12.39 | -1.131 | 1.27 |
| 08/18/00 | 06:15 PM | 13635 | 12.39 | -1.151 | 1.34 |
| 08/18/00 | 06:30 PM | 13650 | 12.54 | -1.171 | 1.40 |
| 08/18/00 | 06:45 PM | 13665 | 12.71 | -1.224 | 1.57 |
| 08/18/00 | 07:00 PM | 13680 | 12.73 | -1.298 | 1.82 |
| 08/18/00 | 07:15 PM | 13695 | 12.62 | -1.287 | 1.78 |
| 08/18/00 | 07:30 PM | 13710 | 12.57 | -1.347 | 1.98 |
| 08/18/00 | 07:45 PM | 13725 | 12.51 | -1.386 | 2.11 |
| 08/18/00 | 08:00 PM | 13740 | 12.53 | -1.445 | 2.30 |
| 08/18/00 | 08:15 PM | 13755 | 12.52 | -1.457 | 2.34 |
| 08/18/00 | 08:30 PM | 13770 | 12.54 | -1.472 | 2.39 |
| 08/18/00 | 08:45 PM | 13785 | 12.55 | -1.51 | 2.51 |
| 08/18/00 | 09:00 PM | 13800 | 12.51 | -1.53 | 2.58 |
| 08/18/00 | 09:15 PM | 13815 | 12.47 | -1.534 | 2.59 |
| 08/18/00 | 09:30 PM | 13830 | 12.38 | -1.568 | 2.70 |
| 08/18/00 | 09:45 PM | 13845 | 12.29 | -1.602 | 2.81 |
| 08/18/00 | 10:00 PM | 13860 | 12.18 | -1.603 | 2.82 |
| 08/18/00 | 10:15 PM | 13875 | 12.03 | -1.605 | 2.82 |
| 08/18/00 | 10:30 PM | 13890 | 11.58 | -1.616 | 2.86 |
| 08/18/00 | 10:45 PM | 13905 | 11.5 | -1.633 | 2.92 |
| 08/18/00 | 11:00 PM | 13920 | 11.39 | -1.601 | 2.81 |
| 08/18/00 | 11:15 PM | 13935 | 11.29 | -1.6 | 2.81 |
| 08/18/00 | 11:30 PM | 13950 | 11.32 | -1.569 | 2.71 |
| 08/18/00 | 11:45 PM | 13965 | 11.53 | -1.577 | 2.73 |
| 08/19/00 | 12:00 AM | 13980 | 11.61 | -1.531 | 2.58 |
| 08/19/00 | 12:15 AM | 13995 | 11.63 | -1.535 | 2.60 |
| 08/19/00 | 12:30 AM | 14010 | 11.67 | -1.542 | 2.62 |
| 08/19/00 | 12:45 AM | 14025 | 11.77 | -1.509 | 2.51 |
| 08/19/00 | 01:00 AM | 14040 | 11.86 | -1.462 | 2.36 |
| 08/19/00 | 01:15 AM | 14055 | 11.91 | -1.438 | 2.28 |
| 08/19/00 | 01:30 AM | 14070 | 11.94 | -1.429 | 2.25 |
| 08/19/00 | 01:45 AM | 14085 | 11.97 | -1.404 | 2.17 |
| 08/19/00 | 02:00 AM | 14100 | 12.01 | -1.393 | 2.13 |
| 08/19/00 | 02:15 AM | 14115 | 12 | -1.364 | 2.03 |
| 08/19/00 | 02:30 AM | 14130 | 12.03 | -1.332 | 1.93 |
| 08/19/00 | 02:45 AM | 14145 | 12.04 | -1.333 | 1.93 |
| 08/19/00 | 03:00 AM | 14160 | 11.97 | -1.293 | 1.80 |
| 08/19/00 | 03:15 AM | 14175 | 11.9 | -1.272 | 1.73 |
| 08/19/00 | 03:30 AM | 14190 | 11.67 | -1.229 | 1.59 |
| 08/19/00 | 03:45 AM | 14205 | 11.62 | -1.228 | 1.59 |
| 08/19/00 | 04:00 AM | 14220 | 11.68 | -1.217 | 1.55 |
| 08/19/00 | 04:15 AM | 14235 | 11.74 | -1.189 | 1.46 |
| 08/19/00 | 04:30 AM | 14250 | 11.71 | -1.202 | 1.50 |
| 08/19/00 | 04:45 AM | 14265 | 11.66 | -1.207 | 1.52 |
| 08/19/00 | 05:00 AM | 14280 | 11.67 | -1.211 | 1.53 |
| 08/19/00 | 05:15 AM | 14295 | 11.58 | -1.213 | 1.54 |
| 08/19/00 | 05:30 AM | 14310 | 11.63 | -1.193 | 1.47 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/19/00 | 05:45 AM | 14325 | 11.73 | -1.23 | 1.59 |
| 08/19/00 | 06:00 AM | 14340 | 11.75 | -1.219 | 1.56 |
| 08/19/00 | 06:15 AM | 14355 | 11.71 | -1.246 | 1.65 |
| 08/19/00 | 06:30 AM | 14370 | 11.64 | -1.236 | 1.61 |
| 08/19/00 | 06:45 AM | 14385 | 11.65 | -1.27 | 1.73 |
| 08/19/00 | 07:00 AM | 14400 | 11.71 | -1.285 | 1.77 |
| 08/19/00 | 07:15 AM | 14415 | 11.69 | -1.263 | 1.70 |
| 08/19/00 | 07:30 AM | 14430 | 11.68 | -1.287 | 1.78 |
| 08/19/00 | 07:45 AM | 14445 | 11.75 | -1.286 | 1.78 |
| 08/19/00 | 08:00 AM | 14460 | 11.85 | -1.331 | 1.93 |
| 08/19/00 | 08:15 AM | 14475 | 11.83 | -1.301 | 1.83 |
| 08/19/00 | 08:30 AM | 14490 | 11.87 | -1.353 | 2.00 |
| 08/19/00 | 08:45 AM | 14505 | 11.99 | -1.336 | 1.94 |
| 08/19/00 | 09:00 AM | 14520 | 11.96 | -1.33 | 1.92 |
| 08/19/00 | 09:15 AM | 14535 | 11.78 | -1.362 | 2.03 |
| 08/19/00 | 09:30 AM | 14550 | 11.68 | -1.339 | 1.95 |
| 08/19/00 | 09:45 AM | 14565 | 11.64 | -1.384 | 2.10 |
| 08/19/00 | 10:00 AM | 14580 | 11.64 | -1.351 | 1.99 |
| 08/19/00 | 10:15 AM | 14595 | 11.64 | -1.341 | 1.96 |
| 08/19/00 | 10:30 AM | 14610 | 11.66 | -1.335 | 1.94 |
| 08/19/00 | 10:45 AM | 14625 | 11.68 | -1.359 | 2.02 |
| 08/19/00 | 11:00 AM | 14640 | 11.71 | -1.349 | 1.98 |
| 08/19/00 | 11:15 AM | 14655 | 11.75 | -1.281 | 1.76 |
| 08/19/00 | 11:30 AM | 14670 | 11.79 | -1.283 | 1.77 |
| 08/19/00 | 11:45 AM | 14685 | 11.83 | -1.338 | 1.95 |
| 08/19/00 | 12:00 PM | 14700 | 11.97 | -1.258 | 1.69 |
| 08/19/00 | 12:15 PM | 14715 | 12.01 | -1.254 | 1.67 |
| 08/19/00 | 12:30 PM | 14730 | 12.07 | -1.213 | 1.54 |
| 08/19/00 | 12:45 PM | 14745 | 12 | -1.217 | 1.55 |
| 08/19/00 | 01:00 PM | 14760 | 12.09 | -1.23 | 1.59 |
| 08/19/00 | 01:15 PM | 14775 | 12.21 | -1.172 | 1.40 |
| 08/19/00 | 01:30 PM | 14790 | 12.36 | -1.128 | 1.26 |
| 08/19/00 | 01:45 PM | 14805 | 12.25 | -1.117 | 1.22 |
| 08/19/00 | 02:00 PM | 14820 | 12.27 | -1.151 | 1.34 |
| 08/19/00 | 02:15 PM | 14835 | 12.07 | -1.09 | 1.14 |
| 08/19/00 | 02:30 PM | 14850 | 11.71 | -1.073 | 1.08 |
| 08/19/00 | 02:45 PM | 14865 | 11.64 | -1.076 | 1.09 |
| 08/19/00 | 03:00 PM | 14880 | 11.11 | -1.135 | 1.28 |
| 08/19/00 | 03:15 PM | 14895 | 10.96 | -1.069 | 1.07 |
| 08/19/00 | 03:30 PM | 14910 | 10.75 | -1.049 | 1.00 |
| 08/19/00 | 03:45 PM | 14925 | 10.4 | -1.031 | 0.94 |
| 08/19/00 | 04:00 PM | 14940 | 9.96 | -1.05 | 1.00 |
| 08/19/00 | 04:15 PM | 14955 | 9.65 | -1.055 | 1.02 |
| 08/19/00 | 04:30 PM | 14970 | 9.16 | -1.036 | 0.96 |
| 08/19/00 | 04:45 PM | 14985 | 8.8 | -1.082 | 1.11 |
| 08/19/00 | 05:00 PM | 15000 | 8.67 | -1.056 | 1.02 |
| 08/19/00 | 05:15 PM | 15015 | 8.43 | -1.083 | 1.11 |
| 08/19/00 | 05:30 PM | 15030 | 8.22 | -1.105 | 1.18 |
| 08/19/00 | 05:45 PM | 15045 | 7.88 | -1.148 | 1.33 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/19/00 | 06:00 PM | 15060 | 7.84 | -1.14 | 1.30 |
| 08/19/00 | 06:15 PM | 15075 | 8 | -1.192 | 1.47 |
| 08/19/00 | 06:30 PM | 15090 | 8.03 | -1.215 | 1.55 |
| 08/19/00 | 06:45 PM | 15105 | 7.96 | -1.243 | 1.64 |
| 08/19/00 | 07:00 PM | 15120 | 7.95 | -1.263 | 1.70 |
| 08/19/00 | 07:15 PM | 15135 | 8 | -1.277 | 1.75 |
| 08/19/00 | 07:30 PM | 15150 | 8.01 | -1.36 | 2.02 |
| 08/19/00 | 07:45 PM | 15165 | 7.96 | -1.367 | 2.04 |
| 08/19/00 | 08:00 PM | 15180 | 8.05 | -1.446 | 2.30 |
| 08/19/00 | 08:15 PM | 15195 | 8.58 | -1.419 | 2.21 |
| 08/19/00 | 08:30 PM | 15210 | 10.25 | -1.481 | 2.42 |
| 08/19/00 | 08:45 PM | 15225 | 10.53 | -1.51 | 2.51 |
| 08/19/00 | 09:00 PM | 15240 | 11.17 | -1.556 | 2.66 |
| 08/19/00 | 09:15 PM | 15255 | 11.71 | -1.559 | 2.67 |
| 08/19/00 | 09:30 PM | 15270 | 12.04 | -1.599 | 2.81 |
| 08/19/00 | 09:45 PM | 15285 | 12.15 | -1.587 | 2.77 |
| 08/19/00 | 10:00 PM | 15300 | 11.64 | -1.61 | 2.84 |
| 08/19/00 | 10:15 PM | 15315 | 10.63 | -1.666 | 3.02 |
| 08/19/00 | 10:30 PM | 15330 | 10.62 | -1.658 | 3.00 |
| 08/19/00 | 10:45 PM | 15345 | 10.38 | -1.647 | 2.96 |
| 08/19/00 | 11:00 PM | 15360 | 10.27 | -1.667 | 3.03 |
| 08/19/00 | 11:15 PM | 15375 | 10.58 | -1.677 | 3.06 |
| 08/19/00 | 11:30 PM | 15390 | 11.76 | -1.631 | 2.91 |
| 08/19/00 | 11:45 PM | 15405 | 11.97 | -1.625 | 2.89 |
| 08/20/00 | 12:00 AM | 15420 | 11.98 | -1.583 | 2.75 |
| 08/20/00 | 12:15 AM | 15435 | 11.84 | -1.573 | 2.72 |
| 08/20/00 | 12:30 AM | 15450 | 11.81 | -1.561 | 2.68 |
| 08/20/00 | 12:45 AM | 15465 | 11.86 | -1.543 | 2.62 |
| 08/20/00 | 01:00 AM | 15480 | 11.88 | -1.514 | 2.53 |
| 08/20/00 | 01:15 AM | 15495 | 11.68 | -1.455 | 2.33 |
| 08/20/00 | 01:30 AM | 15510 | 11.64 | -1.443 | 2.29 |
| 08/20/00 | 01:45 AM | 15525 | 11.8 | -1.433 | 2.26 |
| 08/20/00 | 02:00 AM | 15540 | 12 | -1.344 | 1.97 |
| 08/20/00 | 02:15 AM | 15555 | 12.18 | -1.367 | 2.04 |
| 08/20/00 | 02:30 AM | 15570 | 12.27 | -1.282 | 1.77 |
| 08/20/00 | 02:45 AM | 15585 | 12.45 | -1.287 | 1.78 |
| 08/20/00 | 03:00 AM | 15600 | 12.52 | -1.237 | 1.62 |
| 08/20/00 | 03:15 AM | 15615 | 12.49 | -1.167 | 1.39 |
| 08/20/00 | 03:30 AM | 15630 | 12.35 | -1.178 | 1.42 |
| 08/20/00 | 03:45 AM | 15645 | 12.29 | -1.152 | 1.34 |
| 08/20/00 | 04:00 AM | 15660 | 12.35 | -1.114 | 1.21 |
| 08/20/00 | 04:15 AM | 15675 | 12.35 | -1.099 | 1.16 |
| 08/20/00 | 04:30 AM | 15690 | 12.36 | -1.056 | 1.02 |
| 08/20/00 | 04:45 AM | 15705 | 12.33 | -1.076 | 1.09 |
| 08/20/00 | 05:00 AM | 15720 | 12.31 | -1.069 | 1.07 |
| 08/20/00 | 05:15 AM | 15735 | 12.23 | -1.039 | 0.97 |
| 08/20/00 | 05:30 AM | 15750 | 11.9 | -1.067 | 1.06 |
| 08/20/00 | 05:45 AM | 15765 | 11.43 | -1.037 | 0.96 |
| 08/20/00 | 06:00 AM | 15780 | 11.21 | -1.059 | 1.03 |
| 08/20/00 | 06:15 AM | 15795 | 11.24 | -1.07 | 1.07 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/20/00 | 06:30 AM | 15810 | 11.88 | -1.09 | 1.14 |
| 08/20/00 | 06:45 AM | 15825 | 12.07 | -1.078 | 1.10 |
| 08/20/00 | 07:00 AM | 15840 | 12.28 | -1.116 | 1.22 |
| 08/20/00 | 07:15 AM | 15855 | 12.21 | -1.138 | 1.29 |
| 08/20/00 | 07:30 AM | 15870 | 12.21 | -1.162 | 1.37 |
| 08/20/00 | 07:45 AM | 15885 | 11.75 | -1.186 | 1.45 |
| 08/20/00 | 08:00 AM | 15900 | 11.42 | -1.195 | 1.48 |
| 08/20/00 | 08:15 AM | 15915 | 11.37 | -1.232 | 1.60 |
| 08/20/00 | 08:30 AM | 15930 | 11.31 | -1.229 | 1.59 |
| 08/20/00 | 08:45 AM | 15945 | 11.24 | -1.254 | 1.67 |
| 08/20/00 | 09:00 AM | 15960 | 11.2 | -1.264 | 1.71 |
| 08/20/00 | 09:15 AM | 15975 | 11.18 | -1.297 | 1.81 |
| 08/20/00 | 09:30 AM | 15990 | 11.18 | -1.282 | 1.77 |
| 08/20/00 | 09:45 AM | 16005 | 11.12 | -1.337 | 1.95 |
| 08/20/00 | 10:00 AM | 16020 | 11.16 | -1.351 | 1.99 |
| 08/20/00 | 10:15 AM | 16035 | 11.2 | -1.356 | 2.01 |
| 08/20/00 | 10:30 AM | 16050 | 11.23 | -1.391 | 2.12 |
| 08/20/00 | 10:45 AM | 16065 | 11.4 | -1.396 | 2.14 |
| 08/20/00 | 11:00 AM | 16080 | 11.54 | -1.393 | 2.13 |
| 08/20/00 | 11:15 AM | 16095 | 11.61 | -1.393 | 2.13 |
| 08/20/00 | 11:30 AM | 16110 | 11.64 | -1.401 | 2.16 |
| 08/20/00 | 11:45 AM | 16125 | 11.21 | -1.409 | 2.18 |
| 08/20/00 | 12:00 PM | 16140 | 10.08 | -1.362 | 2.03 |
| 08/20/00 | 12:15 PM | 16155 | 9.34 | -1.369 | 2.05 |
| 08/20/00 | 12:30 PM | 16170 | 9.12 | -1.368 | 2.05 |
| 08/20/00 | 12:45 PM | 16185 | 9.04 | -1.348 | 1.98 |
| 08/20/00 | 01:00 PM | 16200 | 8.62 | -1.325 | 1.91 |
| 08/20/00 | 01:15 PM | 16215 | 8.89 | -1.306 | 1.84 |
| 08/20/00 | 01:30 PM | 16230 | 9.17 | -1.322 | 1.90 |
| 08/20/00 | 01:45 PM | 16245 | 8.59 | -1.29 | 1.79 |
| 08/20/00 | 02:00 PM | 16260 | 8.62 | -1.287 | 1.78 |
| 08/20/00 | 02:15 PM | 16275 | 8.54 | -1.251 | 1.66 |
| 08/20/00 | 02:30 PM | 16290 | 8.51 | -1.251 | 1.66 |
| 08/20/00 | 02:45 PM | 16305 | 8.49 | -1.239 | 1.62 |
| 08/20/00 | 03:00 PM | 16320 | 8.64 | -1.239 | 1.62 |
| 08/20/00 | 03:15 PM | 16335 | 8.75 | -1.217 | 1.55 |
| 08/20/00 | 03:30 PM | 16350 | 8.92 | -1.223 | 1.57 |
| 08/20/00 | 03:45 PM | 16365 | 9.07 | -1.209 | 1.53 |
| 08/20/00 | 04:00 PM | 16380 | 9.04 | -1.2 | 1.50 |
| 08/20/00 | 04:15 PM | 16395 | 9.06 | -1.172 | 1.40 |
| 08/20/00 | 04:30 PM | 16410 | 9.25 | -1.142 | 1.31 |
| 08/20/00 | 04:45 PM | 16425 | 9.95 | -1.153 | 1.34 |
| 08/20/00 | 05:00 PM | 16440 | 9.55 | -1.19 | 1.46 |
| 08/20/00 | 05:15 PM | 16455 | 9.57 | -1.15 | 1.33 |
| 08/20/00 | 05:30 PM | 16470 | 9.73 | -1.197 | 1.49 |
| 08/20/00 | 05:45 PM | 16485 | 9.51 | -1.18 | 1.43 |
| 08/20/00 | 06:00 PM | 16500 | 9.49 | -1.217 | 1.55 |
| 08/20/00 | 06:15 PM | 16515 | 9.16 | -1.251 | 1.66 |
| 08/20/00 | 06:30 PM | 16530 | 9.1 | -1.233 | 1.60 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/20/00 | 06:45 PM | 16545 | 9.23 | -1.283 | 1.77 |
| 08/20/00 | 07:00 PM | 16560 | 9.38 | -1.262 | 1.70 |
| 08/20/00 | 07:15 PM | 16575 | 9.33 | -1.318 | 1.88 |
| 08/20/00 | 07:30 PM | 16590 | 9.12 | -1.345 | 1.97 |
| 08/20/00 | 07:45 PM | 16605 | 9 | -1.367 | 2.04 |
| 08/20/00 | 08:00 PM | 16620 | 8.96 | -1.423 | 2.23 |
| 08/20/00 | 08:15 PM | 16635 | 8.95 | -1.429 | 2.25 |
| 08/20/00 | 08:30 PM | 16650 | 9.04 | -1.494 | 2.46 |
| 08/20/00 | 08:45 PM | 16665 | 9.1 | -1.498 | 2.47 |
| 08/20/00 | 09:00 PM | 16680 | 9.21 | -1.54 | 2.61 |
| 08/20/00 | 09:15 PM | 16695 | 9.2 | -1.557 | 2.67 |
| 08/20/00 | 09:30 PM | 16710 | 9.2 | -1.611 | 2.84 |
| 08/20/00 | 09:45 PM | 16725 | 9.17 | -1.621 | 2.88 |
| 08/20/00 | 10:00 PM | 16740 | 9.14 | -1.614 | 2.85 |
| 08/20/00 | 10:15 PM | 16755 | 9.17 | -1.64 | 2.94 |
| 08/20/00 | 10:30 PM | 16770 | 9.15 | -1.688 | 3.10 |
| 08/20/00 | 10:45 PM | 16785 | 9.19 | -1.703 | 3.15 |
| 08/20/00 | 11:00 PM | 16800 | 9.2 | -1.679 | 3.07 |
| 08/20/00 | 11:15 PM | 16815 | 9.2 | -1.68 | 3.07 |
| 08/20/00 | 11:30 PM | 16830 | 9.18 | -1.693 | 3.11 |
| 08/20/00 | 11:45 PM | 16845 | 9.18 | -1.667 | 3.03 |
| 08/21/00 | 12:00 AM | 16860 | 9.18 | -1.64 | 2.94 |
| 08/21/00 | 12:15 AM | 16875 | 9.1 | -1.633 | 2.92 |
| 08/21/00 | 12:30 AM | 16890 | 8.8 | -1.612 | 2.85 |
| 08/21/00 | 12:45 AM | 16905 | 8.84 | -1.543 | 2.62 |
| 08/21/00 | 01:00 AM | 16920 | 9.08 | -1.564 | 2.69 |
| 08/21/00 | 01:15 AM | 16935 | 9.13 | -1.526 | 2.57 |
| 08/21/00 | 01:30 AM | 16950 | 8.85 | -1.489 | 2.44 |
| 08/21/00 | 01:45 AM | 16965 | 8.55 | -1.405 | 2.17 |
| 08/21/00 | 02:00 AM | 16980 | 8.51 | -1.422 | 2.22 |
| 08/21/00 | 02:15 AM | 16995 | 8.52 | -1.342 | 1.96 |
| 08/21/00 | 02:30 AM | 17010 | 8.64 | -1.317 | 1.88 |
| 08/21/00 | 02:45 AM | 17025 | 8.85 | -1.267 | 1.72 |
| 08/21/00 | 03:00 AM | 17040 | 8.94 | -1.228 | 1.59 |
| 08/21/00 | 03:15 AM | 17055 | 9 | -1.164 | 1.38 |
| 08/21/00 | 03:30 AM | 17070 | 9 | -1.114 | 1.21 |
| 08/21/00 | 03:45 AM | 17085 | 8.99 | -1.084 | 1.12 |
| 08/21/00 | 04:00 AM | 17100 | 9.01 | -1.066 | 1.06 |
| 08/21/00 | 04:15 AM | 17115 | 8.99 | -1.043 | 0.98 |
| 08/21/00 | 04:30 AM | 17130 | 9 | -0.978 | 0.77 |
| 08/21/00 | 04:45 AM | 17145 | 9 | -0.979 | 0.77 |
| 08/21/00 | 05:00 AM | 17160 | 8.99 | -0.951 | 0.68 |
| 08/21/00 | 05:15 AM | 17175 | 8.94 | -0.913 | 0.55 |
| 08/21/00 | 05:30 AM | 17190 | 8.89 | -0.885 | 0.46 |
| 08/21/00 | 05:45 AM | 17205 | 8.88 | -0.906 | 0.53 |
| 08/21/00 | 06:00 AM | 17220 | 8.86 | -0.888 | 0.47 |
| 08/21/00 | 06:15 AM | 17235 | 8.85 | -0.887 | 0.47 |
| 08/21/00 | 06:30 AM | 17250 | 8.86 | -0.892 | 0.49 |
| 08/21/00 | 06:45 AM | 17265 | 8.86 | -0.929 | 0.61 |
| 08/21/00 | 07:00 AM | 17280 | 8.86 | -0.932 | 0.62 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/21/00 | 07:15 AM | 17295 | 8.81 | -0.909 | 0.54 |
| 08/21/00 | 07:30 AM | 17310 | 8.8 | -0.955 | 0.69 |
| 08/21/00 | 07:45 AM | 17325 | 8.8 | -1 | 0.84 |
| 08/21/00 | 08:00 AM | 17340 | 8.79 | -1.012 | 0.88 |
| 08/21/00 | 08:15 AM | 17355 | 8.78 | -1.015 | 0.89 |
| 08/21/00 | 08:30 AM | 17370 | 8.77 | -1.055 | 1.02 |
| 08/21/00 | 08:45 AM | 17385 | 8.77 | -1.089 | 1.13 |
| 08/21/00 | 09:00 AM | 17400 | 8.78 | -1.139 | 1.30 |
| 08/21/00 | 09:15 AM | 17415 | 8.79 | -1.145 | 1.32 |
| 08/21/00 | 09:30 AM | 17430 | 8.8 | -1.21 | 1.53 |
| 08/21/00 | 09:45 AM | 17445 | 8.8 | -1.24 | 1.63 |
| 08/21/00 | 10:00 AM | 17460 | 8.82 | -1.241 | 1.63 |
| 08/21/00 | 10:15 AM | 17475 | 8.83 | -1.278 | 1.75 |
| 08/21/00 | 10:30 AM | 17490 | 8.84 | -1.322 | 1.90 |
| 08/21/00 | 10:45 AM | 17505 | 8.85 | -1.344 | 1.97 |
| 08/21/00 | 11:00 AM | 17520 | 8.85 | -1.316 | 1.88 |
| 08/21/00 | 11:15 AM | 17535 | 8.86 | -1.377 | 2.08 |
| 08/21/00 | 11:30 AM | 17550 | 8.89 | -1.408 | 2.18 |
| 08/21/00 | 11:45 AM | 17565 | 8.92 | -1.431 | 2.25 |
| 08/21/00 | 12:00 PM | 17580 | 8.95 | -1.423 | 2.23 |
| 08/21/00 | 12:15 PM | 17595 | 8.97 | -1.412 | 2.19 |
| 08/21/00 | 12:30 PM | 17610 | 8.98 | -1.412 | 2.19 |
| 08/21/00 | 12:45 PM | 17625 | 9 | -1.422 | 2.22 |
| 08/21/00 | 01:00 PM | 17640 | 9.01 | -1.443 | 2.29 |
| 08/21/00 | 01:15 PM | 17655 | 9 | -1.398 | 2.15 |
| 08/21/00 | 01:30 PM | 17670 | 9.01 | -1.424 | 2.23 |
| 08/21/00 | 01:45 PM | 17685 | 9.04 | -1.419 | 2.21 |
| 08/21/00 | 02:00 PM | 17700 | 9.05 | -1.405 | 2.17 |
| 08/21/00 | 02:15 PM | 17715 | 9.06 | -1.42 | 2.22 |
| 08/21/00 | 02:30 PM | 17730 | 9.09 | -1.367 | 2.04 |
| 08/21/00 | 02:45 PM | 17745 | 9.13 | -1.371 | 2.06 |
| 08/21/00 | 03:00 PM | 17760 | 8.8 | -1.377 | 2.08 |
| 08/21/00 | 03:15 PM | 17775 | 8.91 | -1.372 | 2.06 |
| 08/21/00 | 03:30 PM | 17790 | 9.1 | -1.356 | 2.01 |
| 08/21/00 | 03:45 PM | 17805 | 9.07 | -1.317 | 1.88 |
| 08/21/00 | 04:00 PM | 17820 | 9.21 | -1.321 | 1.89 |
| 08/21/00 | 04:15 PM | 17835 | 9.28 | -1.343 | 1.97 |
| 08/21/00 | 04:30 PM | 17850 | 9.32 | -1.311 | 1.86 |
| 08/21/00 | 04:45 PM | 17865 | 9.33 | -1.273 | 1.74 |
| 08/21/00 | 05:00 PM | 17880 | 9.34 | -1.285 | 1.77 |
| 08/21/00 | 05:15 PM | 17895 | 9.31 | -1.27 | 1.73 |
| 08/21/00 | 05:30 PM | 17910 | 9.27 | -1.3 | 1.82 |
| 08/21/00 | 05:45 PM | 17925 | 9.29 | -1.292 | 1.80 |
| 08/21/00 | 06:00 PM | 17940 | 9.33 | -1.277 | 1.75 |
| 08/21/00 | 06:15 PM | 17955 | 9.33 | -1.302 | 1.83 |
| 08/21/00 | 06:30 PM | 17970 | 9.36 | -1.318 | 1.88 |
| 08/21/00 | 06:45 PM | 17985 | 9.36 | -1.348 | 1.98 |
| 08/21/00 | 07:00 PM | 18000 | 9.34 | -1.35 | 1.99 |
| 08/21/00 | 07:15 PM | 18015 | 9.35 | -1.316 | 1.88 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/21/00 | 07:30 PM | 18030 | 9.24 | -1.372 | 2.06 |
| 08/21/00 | 07:45 PM | 18045 | 9.26 | -1.412 | 2.19 |
| 08/21/00 | 08:00 PM | 18060 | 9.24 | -1.443 | 2.29 |
| 08/21/00 | 08:15 PM | 18075 | 9.13 | -1.427 | 2.24 |
| 08/21/00 | 08:30 PM | 18090 | 9.12 | -1.5 | 2.48 |
| 08/21/00 | 08:45 PM | 18105 | 8.99 | -1.532 | 2.59 |
| 08/21/00 | 09:00 PM | 18120 | 8.94 | -1.54 | 2.61 |
| 08/21/00 | 09:15 PM | 18135 | 8.95 | -1.585 | 2.76 |
| 08/21/00 | 09:30 PM | 18150 | 8.96 | -1.618 | 2.87 |
| 08/21/00 | 09:45 PM | 18165 | 8.92 | -1.644 | 2.95 |
| 08/21/00 | 10:00 PM | 18180 | 8.94 | -1.678 | 3.06 |
| 08/21/00 | 10:15 PM | 18195 | 8.94 | -1.649 | 2.97 |
| 08/21/00 | 10:30 PM | 18210 | 8.97 | -1.697 | 3.13 |
| 08/21/00 | 10:45 PM | 18225 | 8.62 | -1.717 | 3.19 |
| 08/21/00 | 11:00 PM | 18240 | 8.52 | -1.73 | 3.23 |
| 08/21/00 | 11:15 PM | 18255 | 8.51 | -1.731 | 3.24 |
| 08/21/00 | 11:30 PM | 18270 | 8.53 | -1.742 | 3.27 |
| 08/21/00 | 11:45 PM | 18285 | 8.52 | -1.741 | 3.27 |
| 08/22/00 | 12:00 AM | 18300 | 8.51 | -1.728 | 3.23 |
| 08/22/00 | 12:15 AM | 18315 | 8.48 | -1.73 | 3.23 |
| 08/22/00 | 12:30 AM | 18330 | 8.43 | -1.678 | 3.06 |
| 08/22/00 | 12:45 AM | 18345 | 8.37 | -1.651 | 2.98 |
| 08/22/00 | 01:00 AM | 18360 | 8.37 | -1.621 | 2.88 |
| 08/22/00 | 01:15 AM | 18375 | 8.37 | -1.611 | 2.84 |
| 08/22/00 | 01:30 AM | 18390 | 8.37 | -1.571 | 2.71 |
| 08/22/00 | 01:45 AM | 18405 | 8.38 | -1.525 | 2.56 |
| 08/22/00 | 02:00 AM | 18420 | 8.38 | -1.498 | 2.47 |
| 08/22/00 | 02:15 AM | 18435 | 8.35 | -1.429 | 2.25 |
| 08/22/00 | 02:30 AM | 18450 | 8.35 | -1.389 | 2.12 |
| 08/22/00 | 02:45 AM | 18465 | 8.58 | -1.334 | 1.94 |
| 08/22/00 | 03:00 AM | 18480 | 8.75 | -1.283 | 1.77 |
| 08/22/00 | 03:15 AM | 18495 | 8.94 | -1.236 | 1.61 |
| 08/22/00 | 03:30 AM | 18510 | 9.02 | -1.169 | 1.39 |
| 08/22/00 | 03:45 AM | 18525 | 9.04 | -1.081 | 1.11 |
| 08/22/00 | 04:00 AM | 18540 | 9.05 | -1.064 | 1.05 |
| 08/22/00 | 04:15 AM | 18555 | 9.05 | -1.013 | 0.88 |
| 08/22/00 | 04:30 AM | 18570 | 8.84 | -0.962 | 0.72 |
| 08/22/00 | 04:45 AM | 18585 | 8.75 | -0.906 | 0.53 |
| 08/22/00 | 05:00 AM | 18600 | 8.85 | -0.885 | 0.46 |
| 08/22/00 | 05:15 AM | 18615 | 8.89 | -0.856 | 0.37 |
| 08/22/00 | 05:30 AM | 18630 | 8.91 | -0.797 | 0.17 |
| 08/22/00 | 05:45 AM | 18645 | 8.88 | -0.799 | 0.18 |
| 08/22/00 | 06:00 AM | 18660 | 8.94 | -0.741 | -0.01 |
| 08/22/00 | 06:15 AM | 18675 | 8.97 | -0.747 | 0.01 |
| 08/22/00 | 06:30 AM | 18690 | 8.96 | -0.733 | -0.04 |
| 08/22/00 | 06:45 AM | 18705 | 8.99 | -0.734 | -0.03 |
| 08/22/00 | 07:00 AM | 18720 | 8.99 | -0.708 | -0.12 |
| 08/22/00 | 07:15 AM | 18735 | 9.01 | -0.716 | -0.09 |
| 08/22/00 | 07:30 AM | 18750 | 9.03 | -0.731 | -0.04 |
| 08/22/00 | 07:45 AM | 18765 | 8.98 | -0.78 | 0.12 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/22/00 | 08:00 AM | 18780 | 8.9 | -0.789 | 0.15 |
| 08/22/00 | 08:15 AM | 18795 | 8.68 | -0.809 | 0.21 |
| 08/22/00 | 08:30 AM | 18810 | 8.6 | -0.82 | 0.25 |
| 08/22/00 | 08:45 AM | 18825 | 8.57 | -0.882 | 0.45 |
| 08/22/00 | 09:00 AM | 18840 | 8.53 | -0.908 | 0.54 |
| 08/22/00 | 09:15 AM | 18855 | 8.51 | -0.948 | 0.67 |
| 08/22/00 | 09:30 AM | 18870 | 8.53 | -1.007 | 0.86 |
| 08/22/00 | 09:45 AM | 18885 | 8.54 | -1.028 | 0.93 |
| 08/22/00 | 10:00 AM | 18900 | 8.53 | -1.06 | 1.04 |
| 08/22/00 | 10:15 AM | 18915 | 8.55 | -1.116 | 1.22 |
| 08/22/00 | 10:30 AM | 18930 | 8.57 | -1.161 | 1.37 |
| 08/22/00 | 10:45 AM | 18945 | 8.57 | -1.181 | 1.43 |
| 08/22/00 | 11:00 AM | 18960 | 8.6 | -1.246 | 1.65 |
| 08/22/00 | 11:15 AM | 18975 | 8.61 | -1.282 | 1.77 |
| 08/22/00 | 11:30 AM | 18990 | 8.64 | -1.314 | 1.87 |
| 08/22/00 | 11:45 AM | 19005 | 8.69 | -1.337 | 1.95 |
| 08/22/00 | 12:00 PM | 19020 | 8.73 | -1.371 | 2.06 |
| 08/22/00 | 12:15 PM | 19035 | 8.78 | -1.408 | 2.18 |
| 08/22/00 | 12:30 PM | 19050 | 8.77 | -1.401 | 2.16 |
| 08/22/00 | 12:45 PM | 19065 | 8.77 | -1.45 | 2.32 |
| 08/22/00 | 01:00 PM | 19080 | 8.81 | -1.478 | 2.41 |
| 08/22/00 | 01:15 PM | 19095 | 8.78 | -1.462 | 2.36 |
| 08/22/00 | 01:30 PM | 19110 | 8.77 | -1.483 | 2.42 |
| 08/22/00 | 01:45 PM | 19125 | 8.8 | -1.479 | 2.41 |
| 08/22/00 | 02:00 PM | 19140 | 8.8 | -1.507 | 2.50 |
| 08/22/00 | 02:15 PM | 19155 | 8.77 | -1.496 | 2.47 |
| 08/22/00 | 02:30 PM | 19170 | 8.73 | -1.519 | 2.54 |
| 08/22/00 | 02:45 PM | 19185 | 8.75 | -1.496 | 2.47 |
| 08/22/00 | 03:00 PM | 19200 | 8.74 | -1.485 | 2.43 |
| 08/22/00 | 03:15 PM | 19215 | 8.78 | -1.448 | 2.31 |
| 08/22/00 | 03:30 PM | 19230 | 8.77 | -1.469 | 2.38 |
| 08/22/00 | 03:45 PM | 19245 | 8.82 | -1.474 | 2.40 |
| 08/22/00 | 04:00 PM | 19260 | 8.85 | -1.439 | 2.28 |
| 08/22/00 | 04:15 PM | 19275 | 8.86 | -1.44 | 2.28 |
| 08/22/00 | 04:30 PM | 19290 | 8.87 | -1.461 | 2.35 |
| 08/22/00 | 04:45 PM | 19305 | 8.89 | -1.44 | 2.28 |
| 08/22/00 | 05:00 PM | 19320 | 8.87 | -1.403 | 2.16 |
| 08/22/00 | 05:15 PM | 19335 | 8.84 | -1.421 | 2.22 |
| 08/22/00 | 05:30 PM | 19350 | 8.69 | -1.399 | 2.15 |
| 08/22/00 | 05:45 PM | 19365 | 8.73 | -1.394 | 2.13 |
| 08/22/00 | 06:00 PM | 19380 | 8.85 | -1.353 | 2.00 |
| 08/22/00 | 06:15 PM | 19395 | 8.6 | -1.388 | 2.11 |
| 08/22/00 | 06:30 PM | 19410 | 8.55 | -1.372 | 2.06 |
| 08/22/00 | 06:45 PM | 19425 | 8.62 | -1.388 | 2.11 |
| 08/22/00 | 07:00 PM | 19440 | 8.75 | -1.39 | 2.12 |
| 08/22/00 | 07:15 PM | 19455 | 8.76 | -1.411 | 2.19 |
| 08/22/00 | 07:30 PM | 19470 | 8.87 | -1.418 | 2.21 |
| 08/22/00 | 07:45 PM | 19485 | 8.85 | -1.429 | 2.25 |
| 08/22/00 | 08:00 PM | 19500 | 8.79 | -1.458 | 2.34 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/22/00 | 08:15 PM | 19515 | 8.8 | -1.478 | 2.41 |
| 08/22/00 | 08:30 PM | 19530 | 8.9 | -1.514 | 2.53 |
| 08/22/00 | 08:45 PM | 19545 | 8.89 | -1.524 | 2.56 |
| 08/22/00 | 09:00 PM | 19560 | 8.83 | -1.53 | 2.58 |
| 08/22/00 | 09:15 PM | 19575 | 8.73 | -1.595 | 2.79 |
| 08/22/00 | 09:30 PM | 19590 | 8.85 | -1.614 | 2.85 |
| 08/22/00 | 09:45 PM | 19605 | 9.05 | -1.65 | 2.97 |
| 08/22/00 | 10:00 PM | 19620 | 9.22 | -1.647 | 2.96 |
| 08/22/00 | 10:15 PM | 19635 | 9.24 | -1.687 | 3.09 |
| 08/22/00 | 10:30 PM | 19650 | 9.26 | -1.718 | 3.20 |
| 08/22/00 | 10:45 PM | 19665 | 9.25 | -1.746 | 3.29 |
| 08/22/00 | 11:00 PM | 19680 | 9.4 | -1.746 | 3.29 |
| 08/22/00 | 11:15 PM | 19695 | 9.47 | -1.768 | 3.36 |
| 08/22/00 | 11:30 PM | 19710 | 9.46 | -1.783 | 3.41 |
| 08/22/00 | 11:45 PM | 19725 | 9.47 | -1.81 | 3.50 |
| 08/23/00 | 12:00 AM | 19740 | 9.47 | -1.8 | 3.46 |
| 08/23/00 | 12:15 AM | 19755 | 9.47 | -1.807 | 3.49 |
| 08/23/00 | 12:30 AM | 19770 | 9.4 | -1.793 | 3.44 |
| 08/23/00 | 12:45 AM | 19785 | 9.42 | -1.784 | 3.41 |
| 08/23/00 | 01:00 AM | 19800 | 9.47 | -1.76 | 3.33 |
| 08/23/00 | 01:15 AM | 19815 | 9.47 | -1.74 | 3.27 |
| 08/23/00 | 01:30 AM | 19830 | 9.49 | -1.697 | 3.13 |
| 08/23/00 | 01:45 AM | 19845 | 9.49 | -1.662 | 3.01 |
| 08/23/00 | 02:00 AM | 19860 | 9.48 | -1.613 | 2.85 |
| 08/23/00 | 02:15 AM | 19875 | 9.51 | -1.589 | 2.77 |
| 08/23/00 | 02:30 AM | 19890 | 9.46 | -1.533 | 2.59 |
| 08/23/00 | 02:45 AM | 19905 | 9.47 | -1.471 | 2.39 |
| 08/23/00 | 03:00 AM | 19920 | 9.44 | -1.422 | 2.22 |
| 08/23/00 | 03:15 AM | 19935 | 9.28 | -1.374 | 2.07 |
| 08/23/00 | 03:30 AM | 19950 | 9.18 | -1.306 | 1.84 |
| 08/23/00 | 03:45 AM | 19965 | 9.2 | -1.23 | 1.59 |
| 08/23/00 | 04:00 AM | 19980 | 9.2 | -1.164 | 1.38 |
| 08/23/00 | 04:15 AM | 19995 | 9.09 | -1.112 | 1.21 |
| 08/23/00 | 04:30 AM | 20010 | 9.04 | -1.034 | 0.95 |
| 08/23/00 | 04:45 AM | 20025 | 8.99 | -0.988 | 0.80 |
| 08/23/00 | 05:00 AM | 20040 | 8.93 | -0.938 | 0.64 |
| 08/23/00 | 05:15 AM | 20055 | 8.89 | -0.874 | 0.43 |
| 08/23/00 | 05:30 AM | 20070 | 8.85 | -0.827 | 0.27 |
| 08/23/00 | 05:45 AM | 20085 | 8.81 | -0.775 | 0.10 |
| 08/23/00 | 06:00 AM | 20100 | 8.76 | -0.726 | -0.06 |
| 08/23/00 | 06:15 AM | 20115 | 8.73 | -0.699 | -0.15 |
| 08/23/00 | 06:30 AM | 20130 | 8.73 | -0.667 | -0.25 |
| 08/23/00 | 06:45 AM | 20145 | 8.76 | -0.648 | -0.31 |
| 08/23/00 | 07:00 AM | 20160 | 8.78 | -0.605 | -0.46 |
| 08/23/00 | 07:15 AM | 20175 | 8.79 | -0.603 | -0.46 |
| 08/23/00 | 07:30 AM | 20190 | 8.78 | -0.586 | -0.52 |
| 08/23/00 | 07:45 AM | 20205 | 8.78 | -0.594 | -0.49 |
| 08/23/00 | 08:00 AM | 20220 | 8.77 | -0.598 | -0.48 |
| 08/23/00 | 08:15 AM | 20235 | 8.74 | -0.61 | -0.44 |
| 08/23/00 | 08:30 AM | 20250 | 8.72 | -0.64 | -0.34 |

| Date | Time | ET (min) | Chan[1] Celsius | Chan[2] Meters H2O | Bay Elevation Ft MSL |
|---|---|---|---|---|---|
| 08/23/00 | 08:45 AM | 20265 | 8.7 | -0.675 | -0.23 |
| 08/23/00 | 09:00 AM | 20280 | 8.65 | -0.693 | -0.17 |
| 08/23/00 | 09:15 AM | 20295 | 8.63 | 0.05 | -2.60 |
| 08/23/00 | 09:30 AM | 20310 | 10.19 | 0.06 | -2.64 |
| 08/23/00 | 09:45 AM | 20325 | 12.39 | 0.058 | -2.63 |
| 08/23/00 | 10:00 AM | 20340 | 13.6 | 0.059 | -2.63 |
| 08/23/00 | 10:15 AM | 20355 | 14.65 | 0.056 | -2.62 |
| 08/23/00 | 10:30 AM | 20370 | 15.48 | 0.053 | -2.61 |
| 08/23/00 | 10:45 AM | 20385 | 16.17 | 0.046 | -2.59 |
| 08/23/00 | 11:00 AM | 20400 | 16.75 | 0.042 | -2.58 |
| 08/23/00 | 11:15 AM | 20415 | 17.25 | 0.041 | -2.58 |
| 08/23/00 | 11:30 AM | 20430 | 17.66 | 0.041 | -2.58 |
| 08/23/00 | 11:45 AM | 20445 | 18.06 | 0.039 | -2.57 |
| 08/23/00 | 12:00 PM | 20460 | 18.46 | 0.039 | -2.57 |

# Appendix D
# Automated Water Level Data for Well AKI-1

Water Level Measurements for Well AKI-1

| Date | Time | Time (min) | Temperature Celsius | Pressure PSI | Sensor Elv (FT) | Measured Elv (FT) |
|---|---|---|---|---|---|---|
| 08/19/00 | 10:00 AM | 0 | 14.47 | 14.722 | 5.564 | |
| 08/19/00 | 10:30 AM | 30 | 13.73 | 14.721 | 5.563 | |
| 08/19/00 | 11:00 AM | 60 | 14.31 | 14.722 | 5.564 | |
| 08/19/00 | 11:30 AM | 90 | 9.1 | 15.996 | 6.045 | 6.024 |
| 08/19/00 | 12:00 AM | 120 | 8.86 | 15.995 | 6.045 | |
| 08/19/00 | 12:30 PM | 150 | 8.81 | 15.988 | 6.042 | |
| 08/19/00 | 01:00 PM | 180 | 8.8 | 15.977 | 6.038 | |
| 08/19/00 | 01:30 PM | 210 | 8.78 | 15.965 | 6.033 | |
| 08/19/00 | 02:00 PM | 240 | 8.77 | 15.95 | 6.028 | |
| 08/19/00 | 02:30 PM | 270 | 8.77 | 15.935 | 6.022 | |
| 08/19/00 | 03:00 PM | 300 | 8.77 | 15.922 | 6.017 | |
| 08/19/00 | 03:30 PM | 330 | 8.76 | 15.913 | 6.014 | |
| 08/19/00 | 04:00 PM | 360 | 8.76 | 15.906 | 6.011 | |
| 08/19/00 | 04:30 PM | 390 | 8.75 | 15.895 | 6.007 | |
| 08/19/00 | 05:00 PM | 420 | 8.75 | 15.891 | 6.005 | |
| 08/19/00 | 05:30 PM | 450 | 8.73 | 15.887 | 6.004 | |
| 08/19/00 | 06:00 PM | 480 | 8.72 | 15.888 | 6.004 | |
| 08/19/00 | 06:30 PM | 510 | 8.72 | 15.891 | 6.005 | |
| 08/19/00 | 07:00 PM | 540 | 8.69 | 15.896 | 6.007 | |
| 08/19/00 | 07:30 PM | 570 | 8.69 | 15.908 | 6.012 | |
| 08/19/00 | 08:00 PM | 600 | 8.68 | 15.925 | 6.018 | |
| 08/19/00 | 08:30 PM | 630 | 8.67 | 15.941 | 6.024 | |
| 08/19/00 | 09:00 PM | 660 | 8.67 | 15.955 | 6.029 | |
| 08/19/00 | 09:30 PM | 690 | 8.66 | 15.971 | 6.036 | |
| 08/19/00 | 10:00 PM | 720 | 8.64 | 15.987 | 6.042 | |
| 08/19/00 | 10:30 PM | 750 | 8.64 | 16.002 | 6.047 | |
| 08/19/00 | 11:00 PM | 780 | 8.63 | 16.009 | 6.050 | |
| 08/19/00 | 11:30 PM | 810 | 8.62 | 16.016 | 6.053 | |
| 08/20/00 | 12:00 PM | 840 | 8.62 | 16.016 | 6.053 | |
| 08/20/00 | 12:30 AM | 870 | 8.62 | 16.009 | 6.050 | |
| 08/20/00 | 01:00 AM | 900 | 8.62 | 16.002 | 6.047 | |
| 08/20/00 | 01:30 AM | 930 | 8.62 | 15.989 | 6.042 | |
| 08/20/00 | 02:00 AM | 960 | 8.62 | 15.981 | 6.039 | |
| 08/20/00 | 02:30 AM | 990 | 8.63 | 15.959 | 6.031 | |
| 08/20/00 | 03:00 AM | 1020 | 8.64 | 15.945 | 6.026 | |
| 08/20/00 | 03:30 AM | 1050 | 8.64 | 15.929 | 6.020 | |
| 08/20/00 | 04:00 AM | 1080 | 8.64 | 15.914 | 6.014 | |
| 08/20/00 | 04:30 AM | 1110 | 8.64 | 15.898 | 6.008 | |
| 08/20/00 | 05:00 AM | 1140 | 8.66 | 15.886 | 6.003 | |
| 08/20/00 | 05:30 AM | 1170 | 8.66 | 15.878 | 6.000 | |
| 08/20/00 | 06:00 AM | 1200 | 8.66 | 15.872 | 5.998 | |
| 08/20/00 | 06:30 AM | 1230 | 8.67 | 15.866 | 5.996 | |
| 08/20/00 | 07:00 AM | 1260 | 8.67 | 15.87 | 5.997 | |
| 08/20/00 | 07:30 AM | 1290 | 8.67 | 15.873 | 5.999 | |
| 08/20/00 | 08:00 AM | 1320 | 8.67 | 15.88 | 6.001 | |
| 08/20/00 | 08:30 AM | 1350 | 8.67 | 15.887 | 6.004 | |
| 08/20/00 | 09:00 AM | 1380 | 8.67 | 15.895 | 6.007 | |
| 08/20/00 | 09:30 AM | 1410 | 8.67 | 15.902 | 6.009 | |

| Date | Time | Time (min) | Temperature Celsius | Pressure PSI | Sensor Elv (FT) | Measured Elv (FT) |
|---|---|---|---|---|---|---|
| 08/20/00 | 10:00 AM | 1440 | 8.66 | 15.914 | 6.014 | 6.014 |
| 08/20/00 | 10:30 AM | 1470 | 8.64 | 15.923 | 6.017 | |
| 08/20/00 | 11:00 AM | 1500 | 8.63 | 15.937 | 6.023 | |
| 08/20/00 | 11:30 AM | 1530 | 8.63 | 15.945 | 6.026 | |
| 08/20/00 | 12:00 PM | 1560 | 8.63 | 15.95 | 6.028 | |
| 08/20/00 | 12:30 PM | 1590 | 8.63 | 15.946 | 6.026 | |
| 08/20/00 | 01:00 PM | 1620 | 8.63 | 15.943 | 6.025 | |
| 08/20/00 | 01:30 PM | 1650 | 8.63 | 15.942 | 6.025 | |
| 08/20/00 | 02:00 PM | 1680 | 8.64 | 15.938 | 6.023 | |
| 08/20/00 | 02:30 PM | 1710 | 8.64 | 15.933 | 6.021 | |
| 08/20/00 | 03:00 PM | 1740 | 8.64 | 15.931 | 6.020 | |
| 08/20/00 | 03:30 PM | 1770 | 8.64 | 15.928 | 6.019 | |
| 08/20/00 | 04:00 PM | 1800 | 8.64 | 15.923 | 6.017 | |
| 08/20/00 | 04:30 PM | 1830 | 8.66 | 15.922 | 6.017 | |
| 08/20/00 | 05:00 PM | 1860 | 8.64 | 15.916 | 6.015 | |
| 08/20/00 | 05:30 PM | 1890 | 8.64 | 15.916 | 6.015 | |
| 08/20/00 | 06:00 PM | 1920 | 8.64 | 15.918 | 6.016 | |
| 08/20/00 | 06:30 PM | 1950 | 8.63 | 15.925 | 6.018 | |
| 08/20/00 | 07:00 PM | 1980 | 8.64 | 15.936 | 6.022 | |
| 08/20/00 | 07:30 PM | 2010 | 8.63 | 15.944 | 6.025 | |
| 08/20/00 | 08:00 PM | 2040 | 8.62 | 15.962 | 6.032 | |
| 08/20/00 | 08:30 PM | 2070 | 8.62 | 15.979 | 6.039 | |
| 08/20/00 | 09:00 PM | 2100 | 8.62 | 15.996 | 6.045 | |
| 08/20/00 | 09:30 PM | 2130 | 8.61 | 16.017 | 6.053 | |
| 08/20/00 | 10:00 PM | 2160 | 8.61 | 16.035 | 6.060 | |
| 08/20/00 | 10:30 PM | 2190 | 8.59 | 16.054 | 6.067 | |
| 08/20/00 | 11:00 PM | 2220 | 8.59 | 16.071 | 6.073 | |
| 08/20/00 | 11:30 PM | 2250 | 8.59 | 16.082 | 6.077 | |
| 08/21/00 | 12:00 PM | 2280 | 8.59 | 16.085 | 6.079 | |
| 08/21/00 | 12:30 AM | 2310 | 8.59 | 16.082 | 6.077 | |
| 08/21/00 | 01:00 AM | 2340 | 8.59 | 16.074 | 6.074 | |
| 08/21/00 | 01:30 AM | 2370 | 8.59 | 16.071 | 6.073 | |
| 08/21/00 | 02:00 AM | 2400 | 8.61 | 16.058 | 6.068 | |
| 08/21/00 | 02:30 AM | 2430 | 8.62 | 16.048 | 6.065 | |
| 08/21/00 | 03:00 AM | 2460 | 8.63 | 16.03 | 6.058 | |
| 08/21/00 | 03:30 AM | 2490 | 8.64 | 16.011 | 6.051 | |
| 08/21/00 | 04:00 AM | 2520 | 8.66 | 15.996 | 6.045 | |
| 08/21/00 | 04:30 AM | 2550 | 8.66 | 15.981 | 6.039 | |
| 08/21/00 | 05:00 AM | 2580 | 8.66 | 15.966 | 6.034 | |
| 08/21/00 | 05:30 AM | 2610 | 8.66 | 15.949 | 6.027 | |
| 08/21/00 | 06:00 AM | 2640 | 8.67 | 15.94 | 6.024 | |
| 08/21/00 | 06:30 AM | 2670 | 8.68 | 15.931 | 6.020 | |
| 08/21/00 | 07:00 AM | 2700 | 8.67 | 15.93 | 6.020 | |
| 08/21/00 | 07:30 AM | 2730 | 8.67 | 15.927 | 6.019 | |
| 08/21/00 | 08:00 AM | 2760 | 8.67 | 15.932 | 6.021 | |
| 08/21/00 | 08:30 AM | 2790 | 8.68 | 15.939 | 6.023 | |
| 08/21/00 | 09:00 AM | 2820 | 8.68 | 15.945 | 6.026 | |
| 08/21/00 | 09:30 AM | 2850 | 8.67 | 15.958 | 6.031 | |
| 08/21/00 | 10:00 AM | 2880 | 8.67 | 15.97 | 6.035 | |
| 08/21/00 | 10:30 AM | 2910 | 8.66 | 15.983 | 6.040 | |

| Date | Time | Time (min) | Temperature Celsius | Pressure PSI | Sensor Elv (FT) | Measured Elv (FT) |
|---|---|---|---|---|---|---|
| 08/21/00 | 11:00 AM | 2940 | 8.66 | 15.991 | 6.043 | |
| 08/21/00 | 11:30 AM | 2970 | 8.64 | 16.002 | 6.047 | |
| 08/21/00 | 03:00 PM | 3180 | 8.64 | 16.031 | 6.058 | |
| 08/21/00 | 03:30 PM | 3210 | 8.64 | 16.033 | 6.059 | |
| 08/21/00 | 04:00 PM | 3240 | 8.66 | 16.029 | 6.057 | |
| 08/21/00 | 04:30 PM | 3270 | 8.66 | 16.03 | 6.058 | |
| 08/21/00 | 05:00 PM | 3300 | 8.66 | 16.02 | 6.055 | 5.964 |
| 08/21/00 | 05:30 PM | 3330 | 8.66 | 16.01 | 6.052 | |
| 08/21/00 | 06:00 PM | 3360 | 8.71 | 16.00 | 6.049 | |
| 08/21/00 | 06:30 PM | 3390 | 8.68 | 16.008 | 6.050 | |
| 08/21/00 | 07:00 PM | 3420 | 8.68 | 16.00 | 6.050 | |
| 08/21/00 | 07:30 PM | 3450 | 8.68 | 16.015 | 6.052 | |
| 08/21/00 | 08:00 PM | 3480 | 8.68 | 16.024 | 6.056 | |
| 08/21/00 | 08:30 PM | 3510 | 8.67 | 16.035 | 6.060 | |
| 08/21/00 | 09:00 PM | 3540 | 8.67 | 16.048 | 6.065 | |
| 08/21/00 | 09:30 PM | 3570 | 8.66 | 16.063 | 6.070 | |
| 08/21/00 | 10:00 PM | 3600 | 8.66 | 16.081 | 6.077 | |
| 08/21/00 | 10:30 PM | 3630 | 8.64 | 16.095 | 6.082 | |
| 08/21/00 | 11:00 PM | 3660 | 8.64 | 16.112 | 6.089 | |
| 08/21/00 | 11:30 PM | 3690 | 8.64 | 16.121 | 6.092 | |
| 08/22/00 | 12:00 PM | 3720 | 8.63 | 16.126 | 6.094 | |
| 08/22/00 | 12:30 AM | 3750 | 8.63 | 16.126 | 6.094 | |
| 08/22/00 | 01:00 AM | 3780 | 8.64 | 16.123 | 6.093 | |
| 08/22/00 | 01:30 AM | 3810 | 8.64 | 16.113 | 6.089 | |
| 08/22/00 | 02:00 AM | 3840 | 8.64 | 16.099 | 6.084 | |
| 08/22/00 | 02:30 AM | 3870 | 8.66 | 16.083 | 6.078 | |
| 08/22/00 | 03:00 AM | 3900 | 8.67 | 16.062 | 6.070 | |
| 08/22/00 | 03:30 AM | 3930 | 8.68 | 16.04 | 6.062 | |
| 08/22/00 | 04:00 AM | 3960 | 8.69 | 16.011 | 6.051 | |
| 08/22/00 | 04:30 AM | 3990 | 8.69 | 15.992 | 6.043 | |
| 08/22/00 | 05:00 AM | 4020 | 8.71 | 15.971 | 6.036 | |
| 08/22/00 | 05:30 AM | 4050 | 8.71 | 15.951 | 6.028 | |
| 08/22/00 | 06:00 AM | 4080 | 8.73 | 15.937 | 6.023 | |
| 08/22/00 | 06:30 AM | 4110 | 8.73 | 15.919 | 6.016 | |
| 08/22/00 | 07:00 AM | 4140 | 8.73 | 15.908 | 6.012 | |
| 08/22/00 | 07:30 AM | 4170 | 8.73 | 15.899 | 6.008 | |
| 08/22/00 | 08:00 AM | 4200 | 8.75 | 15.896 | 6.007 | |
| 08/22/00 | 08:30 AM | 4230 | 8.75 | 15.895 | 6.007 | |
| 08/22/00 | 09:00 AM | 4260 | 8.75 | 15.896 | 6.007 | |
| 08/22/00 | 09:30 AM | 4290 | 8.75 | 15.903 | 6.010 | |
| 08/22/00 | 10:00 AM | 4320 | 8.73 | 15.907 | 6.011 | |
| 08/22/00 | 10:30 AM | 4350 | 8.73 | 15.917 | 6.015 | |
| 08/22/00 | 11:00 AM | 4380 | 8.75 | 15.931 | 6.020 | 5.734 |
| 08/22/00 | 11:30 AM | 4410 | 8.71 | 15.945 | 6.026 | |
| 08/22/00 | 12:00 PM | 4440 | 8.71 | 15.958 | 6.031 | |
| 08/22/00 | 12:30 PM | 4470 | 8.69 | 15.967 | 6.034 | |
| 08/22/00 | 01:00 PM | 4500 | 8.76 | 15.937 | 6.023 | |

# Appendix E
# Slug Test Data for Well AKI-1

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Akutan Wetland Study
Head of Akutan Bay
Akutan, AK

CLIENT
U.S. Army Corps of Engineers
Anchorage, AK

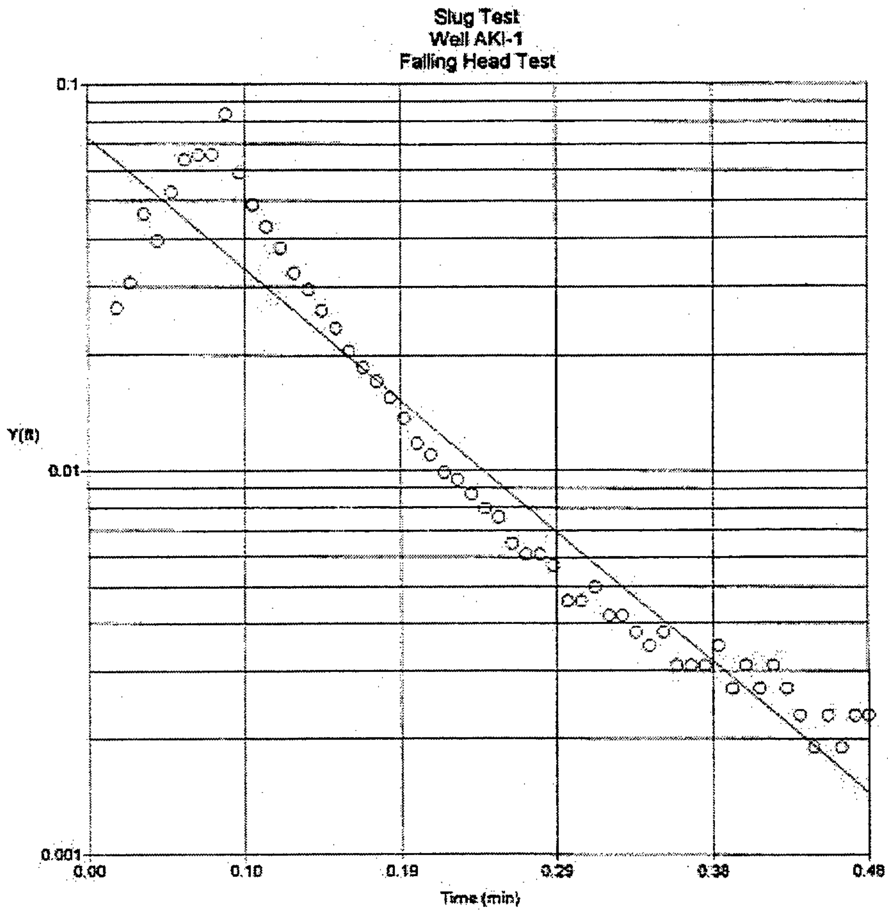
CONSULTANT
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS, 39180

SLUG TEST
Hydraulic conductivity: 0.01 06 cm/sec
Monitoring Well: AKI-1
Test Date: 22 August 2000
Field Testing by: J. B. Dunbar

WELL GEOMETRY
H: 25 ft
Lw: 4.7 ft
Le: 4.65 ft
dw: 3.25 in., rw: 1.63 in.
dc: 1.25 in., rc: 0.625 in.
Drained Filter Pack Porosity (%): 49
Effective Radius (re): 1.22 in.
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 34.3
A: 2.54
B: 0.372
C: 2.14
Ln(Re/rw): 2.28

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -1.37e-01
Intercept: 0.798




| | | |
|---|---|---|
| LUST No.: | Site Name: Akutan Wetland Study | |
| Hydraulic Conductivity: 0.0106 cm/sec | Well: AKI-1 | Slug Test Date: 22 August 2000 |
| Engineer Research Development Center, WES | CGWP: | |

Slug Test Type: Falling head
Recovery Data Type: H: Groundwater Head
Static Water Level: 6.0302 ft

| Time (min) | Recovery: H(ft) | Fit Criteria | Y(ft) | Fit Y(ft) |
|---|---|---|---|---|
| 0 | 6.0302 | Ignore | 0 | 0.0729 |
| 0.0083 | 6.0057 | Ignore | -0.0245 | 0.0681 |
| 0.0167 | 6.0567 | Use | 0.0265 | 0.0635 |
| 0.025 | 6.0609 | Use | 0.0307 | 0.0593 |
| 0.0333 | 6.0764 | Use | 0.0462 | 0.0554 |
| 0.0417 | 6.0696 | Use | 0.0394 | 0.0517 |
| 0.05 | 6.0828 | Use | 0.0526 | 0.0483 |
| 0.0583 | 6.0941 | Use | 0.0639 | 0.0451 |
| 0.0667 | 6.0960 | Use | 0.0658 | 0.0421 |
| 0.075 | 6.0960 | Use | 0.0658 | 0.0393 |
| 0.0833 | 6.1138 | Use | 0.0836 | 0.0367 |
| 0.0917 | 6.0892 | Use | 0.059 | 0.0342 |
| 0.1 | 6.0790 | Use | 0.0488 | 0.032 |
| 0.1083 | 6.0730 | Use | 0.0428 | 0.0299 |
| 0.1167 | 6.0680 | Use | 0.0378 | 0.0279 |
| 0.125 | 6.0627 | Use | 0.0325 | 0.026 |
| 0.1333 | 6.0597 | Use | 0.0295 | 0.0243 |
| 0.1417 | 6.0563 | Use | 0.0261 | 0.0227 |
| 0.15 | 6.0537 | Use | 0.0235 | 0.0212 |
| 0.1583 | 6.0507 | Use | 0.0205 | 0.0198 |
| 0.1667 | 6.0488 | Use | 0.0186 | 0.0185 |
| 0.175 | 6.0473 | Use | 0.0171 | 0.0172 |
| 0.1833 | 6.0457 | Use | 0.0155 | 0.0161 |
| 0.1917 | 6.0439 | Use | 0.0137 | 0.015 |
| 0.2 | 6.0420 | Use | 0.0118 | 0.014 |
| 0.2083 | 6.0412 | Use | 0.011 | 0.0131 |
| 0.2167 | 6.0401 | Use | 0.0099 | 0.0122 |
| 0.225 | 6.0397 | Use | 0.0095 | 0.0114 |
| 0.2333 | 6.0389 | Use | 0.0087 | 0.0107 |
| 0.2417 | 6.0382 | Use | 0.008 | 0.00995 |
| 0.25 | 6.0378 | Use | 0.0076 | 0.0093 |
| 0.2583 | 6.0367 | Use | 0.0065 | 0.00868 |
| 0.2667 | 6.0363 | Use | 0.0061 | 0.0081 |
| 0.275 | 6.0363 | Use | 0.0061 | 0.00757 |
| 0.2833 | 6.0359 | Use | 0.0057 | 0.00707 |
| 0.2917 | 6.0348 | Use | 0.0046 | 0.00659 |
| 0.3 | 6.0348 | Use | 0.0046 | 0.00616 |
| 0.3083 | 6.0352 | Use | 0.005 | 0.00575 |
| 0.3167 | 6.0344 | Use | 0.0042 | 0.00537 |
| 0.325 | 6.0344 | Use | 0.0042 | 0.00501 |
| 0.3333 | 6.0340 | Use | 0.0038 | 0.00468 |
| 0.3417 | 6.0337 | Use | 0.0035 | 0.00437 |

| Time (min) | Recovery: H(ft) | Fit Criteria | Y(ft) | Fit Y(ft) |
|---|---|---|---|---|
| 0.35 | 6.0340 | Use | 0.0038 | 0.00408 |
| 0.3583 | 6.0333 | Use | 0.0031 | 0.00381 |
| 0.3667 | 6.0333 | Use | 0.0031 | 0.00355 |
| 0.375 | 6.0333 | Use | 0.0031 | 0.00332 |
| 0.3833 | 6.0337 | Use | 0.0035 | 0.0031 |
| 0.3917 | 6.0329 | Use | 0.0027 | 0.00289 |
| 0.4 | 6.0333 | Use | 0.0031 | 0.0027 |
| 0.4083 | 6.0329 | Use | 0.0027 | 0.00252 |
| 0.4167 | 6.0333 | Use | 0.0031 | 0.00235 |
| 0.425 | 6.0329 | Use | 0.0027 | 0.0022 |
| 0.4333 | 6.0325 | Use | 0.0023 | 0.00205 |
| 0.4417 | 6.0321 | Use | 0.0019 | 0.00192 |
| 0.45 | 6.0325 | Use | 0.0023 | 0.00179 |
| 0.4583 | 6.0321 | Use | 0.0019 | 0.00167 |
| 0.4667 | 6.0325 | Use | 0.0023 | 0.00156 |
| 0.475 | 6.0325 | Use | 0.0023 | 0.00146 |

BOUWER-RICE SLUG TEST ANALYSIS

SITE
Akutan Wetland Study
Head of Akutan Bay
Akutan, AK

CLIENT
U.S. Army Corps of Engineers
Anchorage, AK

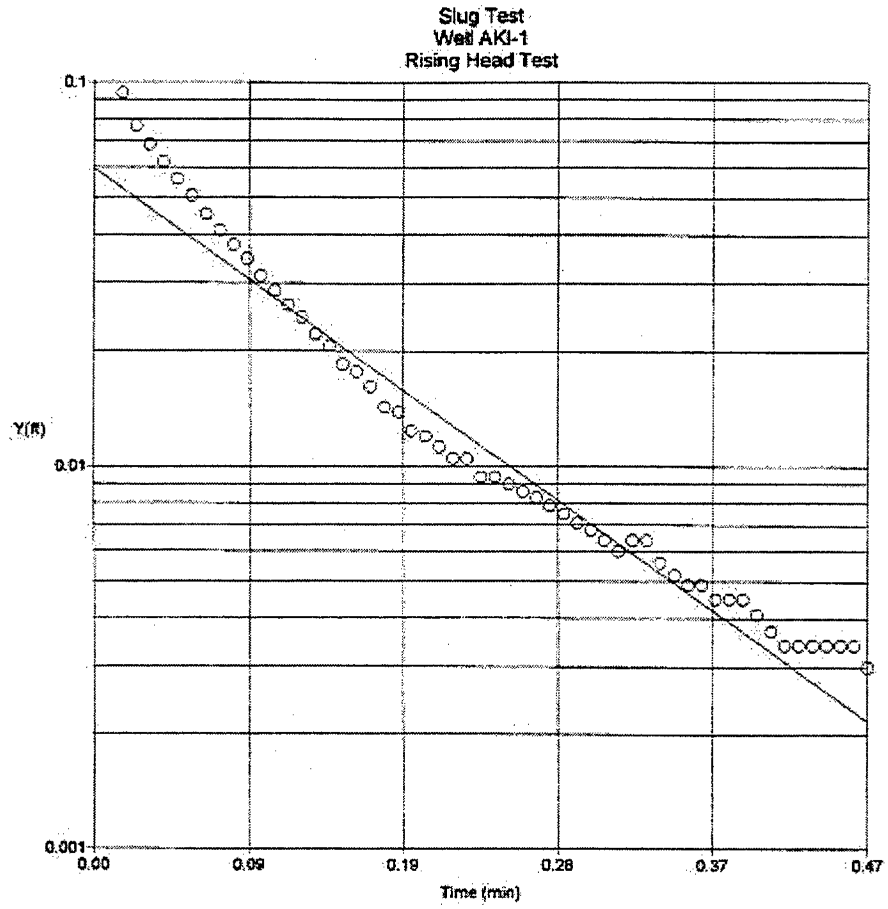
CONSULTANT
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS, 39180

SLUG TEST
Hydraulic Conductivity: 0.0089 cm/sec
Monitoring Well: AKI-1
Test Date: 22 August 2000
Field Testing by: J. B. Dunbar

WELL GEOMETRY
H: 40 ft
Lw: 4.7 ft
Le: 4.65 ft
dw: 3.25 in., rw: 1.63 in.
dc: 1.25 in., rc: 0.625 in.
Drained Filter Pack Porosity (%): 48
Effective Radius (re): 1.21 in.
Slug Volume(L):

BOUWER-RICE COEFFICIENTS
Le/rw: 34.3
A: 2.54
B: 0.372
C: 2.14
Ln(Re/rw): 2.25

LEAST SQUARES BEST FIT
Ln(Y)-cm versus Time-sec
Slope: -1.18e-01
Intercept: 0.592




| | | |
|---|---|---|
| LUST No.: | Site Name: Akutan Wetland Study | |
| Hydraulic Conductivity: 0.0089 cm/sec | Well: AKI-1 | Slug Test Date: 22 August 2000 |
| Engineer Research Development Center, WES | CGWP: | |

Slug Test Type: Rising head
Recovery Data Type: H: Groundwater Head
Static Water Level: 6.0302 ft

| Time (min) | Recovery: H(ft) | Fit Criteria | Y(ft) | Fit Y(ft) |
|---|---|---|---|---|
| 0.0167 | 5.9365 | Ignore | 0.0937 | 0.0527 |
| 0.025 | 5.9532 | Ignore | 0.077 | 0.0497 |
| 0.0334 | 5.9615 | Ignore | 0.0687 | 0.0468 |
| 0.0417 | 5.9683 | Ignore | 0.0619 | 0.0441 |
| 0.05 | 5.9743 | Use | 0.0559 | 0.0416 |
| 0.0584 | 5.9796 | Use | 0.0506 | 0.0392 |
| 0.0667 | 5.9849 | Use | 0.0453 | 0.0369 |
| 0.075 | 5.9891 | Use | 0.0411 | 0.0348 |
| 0.0834 | 5.9925 | Use | 0.0377 | 0.0328 |
| 0.0917 | 5.9955 | Use | 0.0347 | 0.0309 |
| 0.1 | 5.9989 | Use | 0.0313 | 0.0292 |
| 0.1084 | 6.0015 | Use | 0.0287 | 0.0275 |
| 0.1167 | 6.0038 | Use | 0.0264 | 0.0259 |
| 0.125 | 6.0057 | Use | 0.0245 | 0.0244 |
| 0.1334 | 6.0080 | Use | 0.0222 | 0.023 |
| 0.1417 | 6.0095 | Use | 0.0207 | 0.0217 |
| 0.15 | 6.0117 | Use | 0.0185 | 0.0205 |
| 0.1584 | 6.0125 | Use | 0.0177 | 0.0193 |
| 0.1667 | 6.0140 | Use | 0.0162 | 0.0182 |
| 0.175 | 6.0159 | Use | 0.0143 | 0.0171 |
| 0.1834 | 6.0163 | Use | 0.0139 | 0.0161 |
| 0.1917 | 6.0178 | Use | 0.0124 | 0.0152 |
| 0.2 | 6.0182 | Use | 0.012 | 0.0144 |
| 0.2084 | 6.0189 | Use | 0.0113 | 0.0135 |
| 0.2167 | 6.0197 | Use | 0.0105 | 0.0127 |
| 0.225 | 6.0197 | Use | 0.0105 | 0.012 |
| 0.2334 | 6.0208 | Use | 0.0094 | 0.0113 |
| 0.2417 | 6.0208 | Use | 0.0094 | 0.0107 |
| 0.25 | 6.0212 | Use | 0.009 | 0.0101 |
| 0.2584 | 6.0216 | Use | 0.0086 | 0.00949 |
| 0.2667 | 6.0219 | Use | 0.0083 | 0.00894 |
| 0.275 | 6.0223 | Use | 0.0079 | 0.00843 |
| 0.2834 | 6.0227 | Use | 0.0075 | 0.00794 |
| 0.2917 | 6.0231 | Use | 0.0071 | 0.00749 |
| 0.3 | 6.0234 | Use | 0.0068 | 0.00706 |
| 0.3084 | 6.0238 | Use | 0.0064 | 0.00665 |
| 0.3167 | 6.0242 | Use | 0.006 | 0.00627 |
| 0.325 | 6.0238 | Use | 0.0064 | 0.00591 |
| 0.3334 | 6.0238 | Use | 0.0064 | 0.00557 |
| 0.3417 | 6.0246 | Use | 0.0056 | 0.00525 |

| Time (min) | Recovery: H(ft) | Fit Criteria | Y(ft) | Fit Y(ft) |
|---|---|---|---|---|
| 0.35 | 6.0250 | Use | 0.0052 | 0.00495 |
| 0.3584 | 6.0253 | Use | 0.0049 | 0.00467 |
| 0.3667 | 6.0253 | Use | 0.0049 | 0.0044 |
| 0.375 | 6.0257 | Use | 0.0045 | 0.00415 |
| 0.3834 | 6.0257 | Use | 0.0045 | 0.00391 |
| 0.3917 | 6.0257 | Use | 0.0045 | 0.00369 |
| 0.4 | 6.0261 | Use | 0.0041 | 0.00347 |
| 0.4084 | 6.0265 | Use | 0.0037 | 0.00327 |
| 0.4167 | 6.0268 | Ignore | 0.0034 | 0.00309 |
| 0.425 | 6.0268 | Ignore | 0.0034 | 0.00291 |
| 0.4334 | 6.0268 | Ignore | 0.0034 | 0.00274 |
| 0.4417 | 6.0268 | Ignore | 0.0034 | 0.00259 |
| 0.45 | 6.0268 | Ignore | 0.0034 | 0.00244 |
| 0.4584 | 6.0268 | Ignore | 0.0034 | 0.0023 |
| 0.4667 | 6.0272 | Ignore | 0.003 | 0.00217 |

# REPORT DOCUMENTATION PAGE

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**6. AUTHOR(S)**
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**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**

This work supports the environmental impact and feasibility studies by the Planning Division of the U.S. Army Engineer District, Alaska (CEPOA-EN-CW), for the proposed development of a small-boat harbor at the head of Akutan Bay, Akutan Island, Alaska (Figure 1). The commercial fishing industry, the seafood processing industry, and the city of Akutan support development of a harbor facility at the head of Akutan Bay. This location is well-suited because it is ice-free during the winter months. A harbor facility on Akutan Island would increase the capacity of winter storage for the fishing fleet in the Aleutian Islands and bring additional economic growth to the city of Akutan.

Work by the U.S. Army Engineer Research and Development Center (ERDC), for CEPOA-EN-CW for the Akutan Harbor project, involves three separate studies: (1) a wetland delineation, (2) a site survey and development of a digital elevation model, and (3) a geologic/hydrologic assessment. Work for the wetland delineation and the site survey/digital elevation model are presented as separate reports (Wakeley in preparation, Berry and Graves in preparation). This report presents the results of a reconnaissance-level field study to characterize the geology, geomorphology, and hydrology of the proposed harbor area at the head of Akutan Bay.

(Continued)

**15. SUBJECT TERMS**
Akutan Harbor
Alaska
Saltwater intrusion

| 16. SECURITY CLASSIFICATION OF: a. REPORT | b. ABSTRACT | c. THIS PAGE | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(include area code)* |
|---|---|---|---|---|---|
| UNCLASSIFIED | UNCLASSIFIED | UNCLASSIFIED | | 131 | |

14. Abstract (Continued).

The primary purpose for the hydrogeologic investigation was to determine the impacts to the groundwater table from harbor construction. A major environmental concern and focus of this study was to estimate the onshore movement of the saltwater wedge in the impacted area due to harbor construction. Primary objectives of this study were to determine the geology of the harbor area to define important aquifer characteristics of the wetland area. Important aquifer characteristics include the elevation and direction of flow of groundwater, character of the sediments and permeability of the shallow aquifer, and depth to the saltwater wedge.

Tasks performed during the course of this investigation include both field and office work. Field work consisted of a site reconnaissance, an elevation survey, hand augering of soil borings at selected locations, installation of monitoring wells, measurement of water levels in wells and stream gages, and a slug test to determine aquifer permeability. Additional tasks included a background literature survey, geologic mapping from aerial photography, laboratory analyses of selected soil samples, hydrogeologic modeling, data reduction and analyses, and preparation of a final report.

The original purpose of this study was to address the maximum impacts caused by the proposed harbor construction. The harbor outline was changed in April 2001. As now proposed, the harbor is significantly smaller than the maximum project plan on which this study is based (Figure 2). The smaller plan will generally have a smaller impact to the project area than the larger harbor design. The April 2001 harbor boundary is not depicted on illustrations in this report because definition of the new outline postdates the hydrogeologic modeling and completion of the study. The original scope of this study was to look at the larger area and the general impacts. This report also does not address the placement of dredge spoil within the project area and potential impacts to surface drainage and groundwater flow because dredge-spoil impacts were not included in the scope of the original study.